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Cancellation of the June 1945 Meeting in St. Louis

By H. S. ROGERS

President of the Society

The Society for the Promotion of Engineering Education, like all national societies, has had to adjust its program of activities to war time conditions. Among such adjustments, the request of the War Committee on Conventions that all gatherings of more than 50 people, drawn from widely dispersed areas, have the approval of the committee before meeting is, of course, the most important condition which we have to meet. On February 4, the Executive Committee of the Society held a meeting in Pittsburgh and voted to recommend to the Council that it cancel the June 1945 meeting scheduled for St. Louis in accordance with the request of the Government. This recommendation was made after a review of the application for permission to hold a convention and after sufficient time had elapsed to observe the operation of the War Committee on Conventions. Of many hundreds of requests the Committee had authorized at that time only two or three conventions. An examination of the information requested by the Committee and a review of its experience determined the action of the Executive Committee of the Society. In response to the ballot sent to the Council, the vote was overwhelmingly in favor of cancellation.

With such a decision made there are now two major problems confronting the Society. The first is, when and in what manner will the election of officers and new Council members be made, and the second is, how will the omission of the annual meeting affect the operation of the divisions and committees.

Since the meeting of the Council would call together less than 50 people, it will be possible to assemble the group for the transaction of the regular annual business of the Society without the necessity of securing permission from the War Committee on Conventions. It is anticipated the Executive Committee will soon complete such a plan so that Council members may make the necessary arrangements in advance.

In so far as the divisions are concerned, they exercise a rather large measure of autonomy under our Constitution. It would be possible for them to hold mail elections or even to assemble if they desire. Without the annual convention the papers normally presented there, which form so large a part of THE JOURNAL OF ENGINEERING EDUCATION during the succeeding year, will not be available unless other provisions are made. It is, therefore, suggested that the work of these groups go forward just as though the convention were to be held and that papers be distributed to the members of each group. From these the appropriate ones can be sent to the Committee on Publication for use in the JOURNAL. In this manner many of the benefits of the convention can be secured.

We shall all miss the opportunity and privilege of the personal visits and discussions which play so large a part in the significance of our conventions. This loss is, however, a small sacrifice which we shall gladly make as our part of the relief to transportation facilities which the Government tells us is desired and necessary.

Division of Administrative Officers of Engineering Colleges, S.P.E.E.

A committee of the Administrative Division, consisting of S. C. Hollister, T. Saville, and W. E. Wickenden, accompanied by the President of the Society and the Chairman of the Administrative Division, had further conferences on February 28 and March 1, 1945 with representatives of the War Department and of the Navy, with reference to basic principles to which a universal military program should conform. It is hoped that this committee of your Society will prove helpful to our Government in developing a plan for national security which will be completely democratic and acceptable to the people in time of peace.

The War Department is making provisions for an extensive educational program to further the preparation for civilian life of those in the Army of Occupation or awaiting shipment home after the defeat of Germany. No one, however, will be delayed in returning to the United States by participation in this educational program. Preliminary results of studies now under way indicate that there are now on active duty in the Army large numbers of men well qualified by civilian education and experience to teach the various courses in the educational program. Drs. Hollister, Rogers, and Saville conferred on March 1, 1945 with representatives of the War Department who are responsible for this educational program which will generally extend from the elementary school level through the second year of college. In some instances opportunities for more advanced study may be available. There will be a considerable range of textbook courses that might be applicable to students who, upon return to this country, pursue courses in engineering.

Prospective and former students are likely to be writing the engineering colleges of their choice to inquire what courses they should take in the Army program that would best contribute to their plan of study upon their return home. It is recommended that the engineering colleges make every effort to assist such students in making appropriate selections of courses. The Army and the country face a tremendous morale problem due to the enforced delay entailed by the movement of such a large number of men. It is in the national interest as well as in the personal interest of these inquiring students that the colleges assist in this program through extending assurances to such students that any work taken in the Army Training Program will receive careful and objective consideration and appraisal toward advanced standing on return home. The accreditation program developed by the American Council on Education will, no doubt, be utilized by many institutions in evaluating credits.

On March 5, 1945 Albert B. Newman, Chairman of the Committee on Selective Service, and A. A. Potter, Chairman of the Division, attended a conference called by the American Council on Education to consider essential modifications in Selective Service to insure a practical flow of at least minimum quotas of engineers, physicists, chemists, physicians, dentists, and other professional people into training for essential service during the war and in the postwar period. Factual data on the present shortages of engineers are now being collected. The impending shortages in scientific, technological, and health fields must be carefully watched or we may be facing national disaster in the years ahead.

A. A. POTTER, *Chairman*

Report of Committee on Sections and Branches

During the year two new Branches were organized, one at the University of Alabama and the other at the Michigan College of Mining and Technology. Each of these acquisitions has already displayed commendable vigor.

While Sectional activity continued low because of gasoline and travel complications, several profitable meetings were held in some of the more densely populated areas. Some of the Branches were dormant, but others were unusually active.

The committee on Sections and Branches has had a rather busy year. From discussions and correspondence with President Doherty, First Vice-President Cullimore, Secretary Bishop and others soon after the 1943 Annual meeting, it became clear that the Sections and Branches of the Society were not assuming as important a role in the activities of the S.P.E.E. as the current officers and recent past officers of the Society felt they should.

While few would question or minimize the importance of the local activities conducted by the more active Branches and of the annual or semi-annual Sectional gatherings, there was a general feeling that the scope of Sectional and Branch activity needs to be extended to encompass not only the present spread but also to tie up more directly with the activities of the parent Society than has thus far been the case. The sections and Branches are inherently qualified to cope with many important questions that the Society can scarcely touch except through their agency.

Intra-Committee correspondence developed an interesting assortment of questions deemed appropriate for Section and Branch attention. Several of these proposals lay beyond anything previously considered within the province of the local S.P.E.E. groups. The list includes the following:

1. Developing on the part of the upperclassmen and recent graduate (the engineer of tomorrow) an effective sense of professional consciousness, unity and loyalty to the profession as a whole.

2. The promotion of graduate study by talented students and for liaison between faculty, professional honorary societies and student sections of the national professional bodies.

3. The consideration of, and efforts to find solutions for, complex problems in the field of engineering employment, especially among younger engineers many of whom are finding themselves being forced into virtual affiliation with trade union groups.

4. The study and critical evaluation of new techniques and methods such as some of those developed or employed by the E.S.M.W.T., by Army and Navy training programs, and by industrial concerns, with due consideration for differing relative natures of essential course contents and possible fundamental differences in objectives and respective levels of instruction.

5. Sieving out, and assimilating for the benefit of curricula and the teaching profession the gleanings from observations made and experiences gained by faculty men returning from off-campus activities with the armed forces and with industry.

6. Evolving methods for aiding young and other inexperienced faculty

acquisitions to adjust themselves quickly and effectively both to the business of teaching and to the distinctive aspects of a college environment; assimilation and cultivation of teacher material.

7. Rehabilitation of teaching staff; aiding returning staff members in the readjustments and refresher aspects incident to the resumption of academic status.

8. Serving as a forum and a proving ground for proposed modifications in scope and content of engineering curricula.

9. Grappling with general policies and problems arising in connection with the placement and handling of ex-serviceman instruction and allotments of credit for in-service study.

10. Serving as a liaison agency between the engineering college and the secondary schools from which it draws.

11. Promoting closer tie-ups between colleges and industry; between pedagogs and industrialists.

As one step toward broadening the base of operations and making a more thorough canvass of the field it was decided to schedule a convention conference on Sections and Branches at Cincinnati in spite of the inherent conflicts due to the cross-curricular nature of Section-Branch interests which have neither curricular nor organizational lines of cleavage that separate them from any of the divisions or other committees; which characteristic made a no-conflict or low-conflict scheduling impossible.

Confronted with fourteen competing sessions, many of them embracing groups with specialized or demanding interests, it is not surprising that the attendance was small (15 persons). The program, planned as a round-table of 7-minute scheduled and 3-minute unscheduled discussion on "The Role of the Sections and Branches, (a) Now, (b) After the War," was so packed with timely offerings as to create a general feeling that the session was fully justified in spite of the heavy competition from which it suffered. Topics had been selected by the respective program participants mainly from among the list previously enumerated.

S.P.E.E. First Vice-President A. R. Cullimore of the Newark College of Engineering led off with a general discussion of his observations and conceptions of the role that should be played by the Sections and Branches, pointing out the need for a much closer linkage with the activities of the parent Society and a greater interest in the current problems with which the Society might be grappling. In the discussion there was brought out the desirability that the Sections and Branches be definitely informed by the Secretary's office, near the beginning of each working year regarding some of the problems most actively underway, with the thought that in many instances the local activities could be centered about these same questions. In whatever degree this aim materialized, interest in the forthcoming meeting would be stimulated and the membership participation therein could be enhanced both in quantity and quality. Instead of coming to the annual meeting to learn what had been brewing, a larger percentage would come with a background of thought and discussion behind them, prepared to make constructive contributions toward the solution of educational problems while action was still in the formative stage.

N. W. Dougherty, University of Tennessee, discussed, as one of the current needs, "Instruction in Professional Qualities," emphasizing that to teach professional qualities they must be recognized and studied. As distin-

guishing characteristics of professional practitioners he enumerated nine items: (1) a body of technical knowledge, (2) an educational process, (3) a service motive, (4) a relation of confidence, (5) individual responsibility, and group activities, (6) technical and professional organizations, (7) codes of conduct, (8) legal status, and (9) exchange of technical knowledge. He stated that incidental to our teaching we need to develop in the engineering student familiarity with, and pride in, the engineering accomplishments of the past, the questioning attitude of mind, the serious assumption of responsibility, the spirit of service, a sense of teamwork and the ethics of professional relationship to employer, the public and to fellow engineers. In summarizing he stated that the regular engineering courses lend themselves to professional interpretation but that there must be faculty teamwork; that little progress can be expected where the faculty members themselves are not professionally minded.

Gilbert H. Dunstan, Chairman of the active, recently organized Branch at the University of Alabama, discussed "Functions of Sections and Branches." He emphasized teaching problems as a legitimate and desirable activity of the local branch. Rather than scoff at the "education people" because of the frequent over-emphasis placed on method and under-emphasis on knowledge of the subject to be taught, the engineer should be receptive to finding out what the education pepole may have that he can use.

Frequently the informal discussions of teaching aids and course contents (especially for service courses) is more free at a branch meeting that at the more formal faculty meeting. Such free discussion is often beneficial not only to the department more or less under critical fire but also to the critics in learning whereof they speak. The Branch is an admirable medium for the informal preliminary threshing out of all manner of problems for which formal faculty action may be the ultimate requirement.

L. O. Stewart, Iowa State College, Chairman of the North-Midwest Section S.P.E.E., presented a short paper on "The Local Sections as a Proving Ground for Experiments with the Curriculum." Pointing out some of the many unsolved questions in the teaching processes such as those relating to student selection, subject matter and teaching method, Professor Stewart suggested the wider use of aptitude tests, closer scrutiny of course objectives, possible regroupings of subject matter, and the evolution of supervised experimentation for measuring teaching effectiveness and accomplishment. He designated the Section and the the initiation and supervision of such local Branch as the logical medium for activities and for the discussion and interpretation of the results secured. His plea was for the development and use of methods of handling teaching problems comparable to the methods used in our technical fields.

Lisle A. Rose, Chairman of the newly organized and also very active Branch at the Michigan College of Mining and Technology, had selected the topic: "Accreditation and Treatment for Ex-Servicemen." In contending that accreditation for in-service study and the academic placement of ex-service men should be done locally rather than by some regional or national body, Professor Rose partly quoted and partly paraphrased the words of the S.P.E.E. Committee on Credits for In-Service Study (November 1943): "It is clearly the responsibility of the . . . college in which the returning student registers

. . ., following its own procedures to determine" what credits it will accept or assign, in what curricula and for what diplomas.

He believes the local branch to be superior to other local agencies because it is more representative than a dean, registrar, veteran's representative, or a few selected individuals. It is not restricted to either top or low ranking individuals and contains both teachers and administrators.

Democracy, efficiency and proper speed of decision and action are set forth as touchstones for the choice of the best local accrediting agency. He believes the Branch to be inferior to a well-chosen committee in no respect and superior in most. Moreover he believes that the task is as worthy of Branch attention, time and effort as any that could be selected.

G. L. Sullivan, of the University of Santa Clara, member of the 1943–44 Committee on Sections and Branches, discussed the question of "Teaching Teachers to do a Better Job." As an entirely suitable activity for local S.P.E.E. groups, Dean Sullivan suggests give-and-take demonstrations and criticisms following discussions of methods in which are made such concrete suggestions as: "Do not spend class time writing material on the board for students to copy; have such material dittoed for distribution." Among the fallacies to be overcome are: the idea that because one knows a subject he can teach it efficiently, a failure to appreciate that familiarity with educational psychology and teaching methods can contribute much to teaching effectiveness, even in the field of engineering. Many valuable suggestions can be obtained from such books as Pressy's "Psychology and the New Education" and Commins' "Principles of Educational Psychology." The dean or a head of department may well give the first demonstration after which some of the newer staff members may be alternated with old timers, some of whom may be jolted out of their ruts when called upon to defend their methods or to answer critical questions. This demonstration, give-and-take, open-forum approach can be used to drive home the fact that many elements besides subject matter influence the quality of teaching, some of these being: the attitude toward students, methods of answering questions, and the promotion of student discussions.

C. E. Bennett, Chairman of the University of Maine Branch, briefly outlined some of the activities in which they had recently been engaged under the title "The Role of the S.P.E.E. Branch at Maine."

Also participating in discussions of the several presentations were: C. J. Posey, University of Iowa; H. G. Haynes, the Citadel, Secretary, Southeastern Section; L. L. Patterson, Mississippi State College, Vice-Chairman, Southeastern Section; M. E. Haas, University of Dayton, Chairman, Ohio Section; P. E. Mohn, University of Illinois, Chairman, Illinois-Indiana Section; Harvey R. Goslee, Ziff-Davis Publishing Company.

R. A. White, Grand Rapids Junior College and member of the 1943–44 Committee on Sections and Branches, served as Secretary of the Conference.

With the adjournment of the Conference Session the activities of the Committee on Sections and Branches were taken over by a new committee of which Second Vice-President H. M. Crothers of South Dakota State College is the Chairman.

H. J. GILKEY,
Second Vice-President
S.P.E.E. 1943–44

The Compensation of Managers

By DONALD B. PRENTICE

President, Rose Polytechnic Institute

Favorite targets for those who criticize large corporations and the so-called capitalistic form of organization in general are the high salaries received by individuals on the upper administrative levels. Lack of accurate information in most cases, prodded by many rumors and a few true, but exceptional, figures, has created the impression that the cost of management is exorbitant and the earnings of top executives utterly unreasonable. Even if nominal salaries were too high, the current income surtaxes would reduce the net to a level surely considered moderate. But the question should be judged on a long-time basis, without more than a passing reference to present income tax reductions.

Salaries are necessarily relatively large or small, depending on the training, experience, capacities, and responsibilities of the individuals receiving them. We now have information with which to analyze personal remunerations in relation to other corporate expenses, and this article is such a study of forty nationally known organizations. The author realizes that there are other methods of compensating managers in addition to the payment of salaries; stock sales at less than market prices, expense accounts, company automobiles and chauffeurs, and many other "allowances" add to the real incomes of top executives. These perquisites have doubtless increased as income taxes have taken more and more of salaries. A corporate executive with independent income would not retain a sum from his salary under present tax laws sufficiently large to compensate in even small degree for the worries and responsibilities of the position. The amounts of these unpublished "returns" cannot, of course, be estimated, and the author must use the official salaries. Perhaps the hidden payments no more than offset the personal tax costs.

Rules of the Securities and Exchange Commission in connection with the solicitation of proxies by the officers of corporations have made available to the general public hitherto restricted information on the salaries of executives. A request sent to a stockholder for his proxy for use at a meeting at which directors of a corporation are to be chosen must be accompanied by data on the compensation, not only of the directors to be elected or reelected, but also of all the officers, directors and other employees of the company whose individual remuneration exceeded $20,000 for the previous fiscal year. A salary above $20,000 is without doubt liberal, and far beyond the average earnings of American employees. Also it is true that many positions of considerable managerial responsibility carry compensation at or below $20,000 a year. However, this

study is an investigation of salaries called exorbitant by those who object, and the $20,000 line, drawn by the S.E.C., must be considered a satisfactory division.

Study of the proxy solicitations, annual reports and financial statements of the assorted corporations used for this investigation yielded the data tabulated on page . Payments made to pension funds for the benefit of individuals were added to the current salaries of these individuals in determining personal remunerations. Wide variations were to be expected, as the companies are engaged in quite unrelated fields. However, certain comparisons within groups can be made and the results are believed to be significant.

In general, the evidence does not support the exorbitant managerial salary theory. For no company are top managerial salaries collectively as high as two cents out of every dollar of gross business, and the average is almost exactly one-half of one cent. Surely one-half of one per cent is a reasonable proportion of sales to spend for managerial direction. Statistically, the median or middle value of this ratio is of more significance than the average. The median is .398, well below the average, and correspondingly more conservative.

Management, of course, buys material as well as directs men. However, the ratio of managerial salaries to wages is a significant item, particularly as it might be argued that less compensation to those guiding a business should mean more compensation to the other employees. In the organizations here considered, the ratio averages 1.64 per cent. If all those in authority who receive more than $20,000 a year were dismissed, or worked without pay, wages could be raised only 1.64 cents on the dollar. While it cannot be proved, it is certainly a reasonable conclusion to draw that the managerial talent represented by these high salaried individuals contributes more than two per cent to the earning power of the other employees. Without the experience and direction of the officers and managers, an industry could readily slump more than two per cent. For comparison, it is interesting to note at this point that managerial salaries averaged 14.64 per cent of dividends, which is nine times the ratio to wages. The stockholders, who are owners of these companies, are in control, in the last analysis, of salaries. They are evidently willing to reduce potential dividends by one-seventh to provide the calibre of management represented by the high salaried executives.

For sixteen of the forty companies it was possible to determine the managerial salaries in dollars per year per workman. The average was $32.53, or about sixty cents per week. If the retail merchandising organization is omitted, the manufacturing, railroad and utility companies average $26.70 per employee per year or almost exactly fifty cents per week. Surely this is not too much, in proportion to wages, to spend for managerial services.

An impression is occasionally voiced that one or two individuals in a company receive a lion's share of the managerial salary quota. From the statements accompanying proxies it is possible to determine maximum individual compensations and the fraction of total higher managerial salaries concentrated on the top man in a corporation. The range of highest salaries and pension allowances, combined, in the forty companies under

consideration is from $25,000 to $245,455. As percentages of gross business, the range is from .005 to .4, the high ratio applying to a small railroad. For this same small railroad, 35 per cent of managerial salaries go to one man, and this is the maximum concentration in any company in the list. The minimum percentage is 3.7 and the average 14.97. If the corporate financial policies of the companies whose records form the basis for this study are typical, the concentration of remuneration on leading executives is not excessive. An average of 15 per cent of managerial salaries as compensation for the man who must, in

TABLE 1

	Average Ratio of Management Salaries to Volume of Business (Gross Sales) (In Per Cent)
Seven railroads	.244
Four steel companies	.389
Three chemical companies	1.06
Five metal mining and refining	.584
Two electrical companies	.174
Two rubber companies	.324
Six utilities	.357

TABLE 2

Company	Ratio of Management Salaries (in per cent) to:					Management Salaries per Employee per Year	Ratio of Maximum Individual Compensation (in per cent) to:	
	Volume of Business	Wages	Taxes	Net Earnings	Dividends		Volume of Business	Total Mgmt. Salaries
Allied Chemical	.45	2.1	6.2	6.6	9.5		.044	9.9
American Agric. Chem.	.8		16.2	13.6	25.8		.16	20.7
American Can	.62		8.8	10.5	11.4	$56.00	.08	12.9
American Gas and Electric	.41		1.5	2.8	3.3		.07	17.2
American Rolling Mill	.49	1.75	11.1	16.2	20.2	46.80	.056	11.3
American Smelting & Refining	2.6*		9.5	7.4	9.6		.32	11.6
American Sugar Refining	.25		14.5	9.5	9.5		.047	18.5
American Telephone and Telegraph	.26	.45	1.2	2.3	2.6	9.90	.013	4.9
Anaconda Copper	.46		6.3	6.0	9.4	35.90	.045	9.9
Associated Dry Goods	1.4	7.7	15.9	51.8	78.5	120.00	.14	9.8
Bangor and Aroostook	1.1		5.1	7.9	29.1		.4	35.4
Bethlehem Steel	.24	.52	2.8	14.5	19.0	16.00		
Cities Service	.257		2.5	4.2			.053	20.7
General Electric	.13	.40		4.0	4.5	10.60	.005	3.7
B. F. Goodrich Company	.23		1.3	7.5	18.7		.041	17.5
Great Northern Railway	.113		.467	1.17	4.5		.03	26.5
Inland Steel	.65	2.6	5.9	12.4	18.2		.043	6.5
International Nickel	.63		5.2	3.4	3.4	48.00	.114	18.5
International Paper Company	.41		3.4	10.7	19.3		.046	11.5
Kansas City Southern	.33		1.56	4.95	33.5		.084	25.7
Kennecott Copper Company	.27		1.35	1.67	2.17	25.50	.0477	17.9
Lehigh Portland Cement	1.22	3.7	20.7	12.7	16.1		.193	15.8
Loose-Wiles Biscuit	.385		3.94	11.5	47.0		.098	25.5
National Lead Company	.483		6.8	13.7	18.5		.103	21.4
New York Central Railroad	.0773		.447	.87	5.65	4.70	.0131	17.0
New York Power and Light	.32		1.41	3.47	6.25		.0805	25.2
North American Company	.544		2.46	3.34	4.25		.0466	8.6
Pennsylvania Railroad	.135	<.67	.734		4.02		.01135	8.4
Public Service of New Jersey	.352	1.265	1.45	4.06	4.21	33.90	.0545	15.5
Radio Corporation of America	.518		4.94	14.9	25.6	37.50	.0341	6.6
Southern Pacific Company	.0726		.343	.745	5.74		.0107	14.8
Standard Oil Company (Indiana)	.202		2.29	2.03	4.47	32.30	.0228	11.2
Union Carbide & Carbon	1.94		3.8	7.88	10.8		.096	5.0
Union Pacific Railroad	.0782		.299	.83	2.17		.0157	20.0
United Fruit Company	1.7*		9.7	3.67	6.05		.198	11.7
U. S. Playing Card Company	1.3		8.18	17.3	22.3		.293	22.5
U. S. Rubber Company	.418	.94	2.98	12.5	25.3	19.80	.0356	8.5
U. S. Smelting, Refining & Mining	1.075				12.7		.165	15.3
U. S. Steel	.175	.398	2.67	5.45	5.75	10.15	.00788	4.5
Westinghouse E & M Company	.217	.49	1.88	6.95	12.1	13.45	.0343	15.9
Average	.5003	1.641	5.15	8.42	14.64	32.53	.04956	14.97

* Gross profit.

the last analysis, assume full responsibility for directing all the affairs of the company, seems reasonable.

Using the ratio of managerial salaries to dollar volume of business, we find some interesting contrasts between types of organizations. Table 1 presents the averages for seven groups.

It should be noted that industries for which extensive research is a characteristic activity do not necessarily have higher managerial or administrative salaries. Newer industries perhaps have higher costs than older; the contrast between the chemical and electrical groups is marked.

The closeness of percentages for managerial salaries of three great railroad systems, New York Central, Southern Pacific and Union Pacific, is remarkable. As for all businesses, managerial costs run proportionately higher for small railroads than for large.

Of the thirty-eight values reported, twenty-six management-sales ratios fall below the average for the group (one-half of one per cent) and only seven are above one per cent. For eight companies, twenty per cent, the ratios lie between .2 and .3 per cent.

Readers will have their own standards for judging the personal remuneration an individual is entitled to receive. If those standards are arbitrary, if "no man is worth more than $ . . . ." is the basis, then it will be well to repeat that federal surtaxes, to say nothing of possible additional state levies, reduce even the higher salaries listed in this article to moderate amounts. If the standards are "relative to other items in the financial statement," any notion of exorbitant payments must be refuted by the facts of these reports.

It may be claimed that the companies whose financial items were used are not typical of American corporations. That must necessarily be a matter of opinion. It is a fact, however, that the companies listed are all that were analyzed, there has been no omission or substitution, and the selection was made for variety and before any ratios were calculated.

Engineering Extension Legislation*

By J. O. KELLER

Assistant to the President, in Charge of Extension, The Pennsylvania State College

The subcommittee on technical institutes of the Engineers' Council for Professional Development points out in its report of April, 1944, that "Among the important industrial nations of the world it is only the United States in which technical schools of intermediate level render a relatively unimportant and generally inadequately recognized service in preparing personnel for the vast number of jobs in the middle brackets of industrial and engineering pursuits." Obviously we should not permit a wide gap to exist in our educational structure.

Our nation does suffer from lack of persons trained in these brackets. At the beginning of the war production effort, for example, a high official of a machine tool company declared their bottleneck to be trained supervision. Modern industry needs better trained personnel in the intermediate levels of management. A great educator has said: "The greatest loss that we as a nation suffer is loss of talent. Talent is not the heritage of the rich but is equally the heritage of the poor."

We are beginning to appreciate this shortcoming in our educational system. It is being recognized that lack of finances should not prevent an able student from continuing his studies to the fullest extent of his capabilities. Government programs such as E.S.M.W.T., the broad educational programs for members of the armed services, and the educational provisions of the "G.I. Bill of Rights" will tend to bring mass adult education. It would seem to be sound policy for us to provide educational opportunities up to the saturation point as an informed citizenry forms a stronger nation.

Offerings of this intermediate terminal type of education should not be limited to large centers of population which can support more or less permanent institutions of technical education. Smaller industrial centers should have available temporary class center instruction of the same intermediate type. If the need changes in such centers, offerings can change or be dropped entirely. In a one-industry town class offerings should dovetail closely with the needs of that industry, while in larger centers curricula of a more general nature, yet related to needs of local industry, can be offered. At The Pennsylvania State College we have offered since 1912 terminal education of this nature in our extension technical schools and class centers. Purdue University has set up recently a division of technical institutes.

Other courses from campus curricula should also be offered by alert engineering schools and colleges where they are not now available. At The Pennsylvania State College, in three

*Presented at the meeting of Division of Administrative Officers of Engineering Colleges, S.P.E.E., Chicago, October 23, 1944.

separate instances recently, large corporations have asked our engineering school to offer courses to graduate engineers in their company plants. Our department of architecture and architectural engineering is now offering, and finding big demand for, a short informal course of six sessions on the subject of buying or building your own home. This is an example of the great variety of short courses, conferences, institutes, and similar brief training projects by which engineering schools can serve the special educational needs and interests of occupational and professional groups. Engineering educators are aware of the real service performed by E.S.M.W.T. It serves, with a limited offering of courses, the need for upgrading on particular jobs to meet the exigencies of war-time production, and very likely a similar program will be needed to meet reconversion needs.

We should not be surprised to discover that developments of this nature would bring colleges and universities face-to-face with many delicate problems. For example, is this potentially broad program of adult education a job for public institutions, private institutions, or both? Secondly, the question of credit for off-campus instruction is sometimes raised and therein rests a story in itself because we are treading on more or less sacred ground. Some of the 125 graduate engineers in one of the plants just referred to, who wanted advanced courses, were interested in the credit feature.

Again, should such educational offerings be available free of charge, or at most, a small fee? Immediately is introduced the question of Federal aid to education. Up to this time, off-campus services of our universities have been carried on with budgets largely dependent on fees income from extension projects, plus relatively small amounts which could be spared from general institutional funds. Financial starvation forces extension divisions to charge relatively large fees and to shape activities so that they may carry on, irrespective of social needs. Faced with this limitation and the competition of other well-subsidized adult education agencies, the potential student body for university extension has been an inconsiderable fraction of the adult population. The great vocational educational program of the public schools is free and federally supported, as is also the agriculture and home economics extension service of the land-grant institutions.

My own conviction is something like this: that, if we are to really make this kind of educational service available on a national basis, it requires the stimulus of federal appropriations in reasonable amount to bring about its development. Such federal grants, however, must have proper respect for our traditional local rights in education. I am a firm believer in charging a small, reasonable fee for enrollment in such classes, but not to an extent that it prohibits many persons from taking advantage of such opportunities. Large fees, it seems to me, strike a seriously jarring note in the nation-wide development which we want to bring about.

Yet another question which should receive attention is the responsibility of resident subject-matter divisions for the quality of extension teaching. However, I shall not dwell on the matter here. These are all problems for straightforward, honest study.

I return now to the point made earlier regarding gaps in our educational structure. When the Smith

Lever and its subsequent related acts were passed they made provision for an extension of the educational facilities of agricultural and home economics colleges to rural areas. Many students of adult education now consider agricultural extension to be one of the most influential adult education agencies in existence. Its program has had a profound influence upon agricultural production and rural life. Improved practices have been demonstrated to skeptical adults by effective techniques of adult education and have produced prompt results. *But other schools and colleges in our universities can also provide worthwhile adult education services for large groups of people.*

Accordingly, there was introduced in the last Congress a bill—S-1670—by Senator Thomas, chairman of the Senate committee on education and labor. Its purpose is to establish a publicly-supported adult education program through state universities and land-grant colleges by setting up college and university adult education extension separate from but supplemental to the coöperative agricultural extension service. Duplication of instruction authorized by agricultural extension legislation and by the federally-financed vocational education program is not permitted. Other provisions have been added and are being considered so as to eliminate harmful competition and wasteful duplication from other publicly-supported adult educational programs, including those of the public schools. All matters having to do with selection of teachers, control of educational methods, determination of course content, prerequisites and standards of instruction are explicitly reserved to direction by the individual states through their public state institutions of higher learning.

While not explicitly stated, it is implied that state institutions may cooperate with private institutions of higher learning in offering special community programs of instruction. A later draft of the bill will no doubt contain a forthright statement to this effect. When this bill was drawn we were aware of the splendid contribution made by the privately endowed institutions to the war effort through E.S.M.W.T. and other service programs. The fact remains, however, that unless this bill provides for the administration of funds through not more than two or three institutions in each state, its administration would be difficult. There are states where in case of a relaxation of the wording, such a step would result in at least 30 institutions fighting for the crumbs of the appropriation. We must make certain, by providing for sub-contractual arrangements or otherwise, that the outstanding privately endowed engineering colleges and such great institutions as Columbia, Chicago, Harvard, New York University, and others, including the large municipal institutions, have an opportunity to serve if interested.

The bill already provides in its revised form that any program of instruction given by a public institution must parallel a field of subject-matter taught or research carried on by said institution on its campus; but that a certified institution may offer instruction in other subject-matter fields in cooperation with another institution of higher learning which offers such instruction on its campus, in which case the coöperating institution shall supervise the instruction.

Let me say parenthetically that another method has been proposed, different from that in S-1670, under

which the federal government could subsidize such a program. It is the so-called "contract" plan. Under this arrangement educational services might be purchased by the federal government as was the case with several wartime training programs. There is greater likelihood, however, under this method of federal control of education and of the government dictating details of programs of studies, or of methods and techniques employed, and groups served.

This bill, S-1670, carries an appropriation graduated from $8,000,000 the first year to $20,000,00 in 1948, with that amount remaining fixed annually thereafter. Payments are allotted among the states on the basis of population. Twenty-five per cent of any grant made must be matched from state or local sources. Administration of the bill in Washington is placed in the hands of the United States Commissioner of Education. His duties are limited to allotting and certifying payments to colleges and universities, reviewing plans or proposals prior to certifying funds, and preparing an annual report to the Congress. In reviewing an institutional plan, the Commissioner is limited in the manner described earlier.

The bill is sponsored by the National University Extension Association, an organization composed of the extension divisions of 62 of our larger colleges and universities. It also has the support of other large national and state groups. The engineering profession in a large measure has the responsibility for providing technical personnel for our nation, including also the responsibility for making recommendations for the future development of training programs for this purpose. It is hoped that engineering educators will give serious consideration to this measure as a means of enriching our educational structure.

Vacations With Work

By ROBERT F. LEGGET

Associate Professor of Civil Engineering, University of Toronto

The coöperative plan of engineering education was naturally an item of special interest at the Cincinnati (1944) meeting of the Society. Many members were enabled to discuss details of the pioneer work done at the University of Cincinnati with members of the staff of that institution now responsible for the conduct of coöperative work. This was an enlightening experience, leading to numerous private discussions of the matter and clearing up, in the minds of some at least, previous misconceptions about this important type of work.

This general interest in the combination of the theoretical and practical aspects of engineering education is reflected in a recent announcement by J. K. Finch, Acting Dean of the School of Engineering at Columbia University. "Columbia is now considering compulsory summer employment in postwar years for all engineering students" Professor Finch has stated. He has suggested that industry will recognize its responsibility for assisting with practical training and also the opportunities presented by the employment of undergraduate students in summer months. (*Eng. News-Record,* 3rd August, 1944.)

This project is not unlike the corresponding plan followed generally by the engineering faculties of Canadian universities. In discussions at Cincinnati, the writer was frequently asked about Canadian practice in this branch of university work. Comparisons between Canadian and American practice in many phases of engineering educational work are sometimes unprofitable if only because of the different background conditions involved. The practical aspects of engineering training, however, seem to be an exception judging by the interest shown in Canadian practice during the discussions just mentioned. The following notes are therefore submitted as a contribution to general consideration of this important phase of the work of members of the Society. They describe merely the practice at one Canadian university, the University of Toronto, practice that has been evolved gradually through the years and found to be reasonably satisfactory in operation.

Underlying the detailed arrangements for "Vacation Work," as it has to be called, are certain basic concepts with regard to engineering education. In the first place, the undergraduate degree at Toronto is that of Bachelor of Applied Science: correspondingly, the first graduate degree is that of Master of Applied Science. The word "Engineer" is used only in the so-called professional degrees (Civil Engineer, etc.) which may be awarded to graduates only after satisfactory evidence has been presented attesting to the practical experience of the graduate (at least three years) upon part of

which a thesis must be presented. This distinction between applied science, on the one hand, and the practice of engineering, on the other, was originally made and has been maintained at Toronto deliberately, the intention being to emphasize to the young graduate that he is really only starting his training as an engineer upon graduation, against the background provided by his study of the fundamental sciences at the University.

For young men to make a sudden transition upon graduation from the cloistered study of the classroom to the severely practical work of the shop or construction project would, of course, be as unfortunate as it is undesirable. Correspondingly, for an undergraduate to go through his four sessions of university work without seeing in practice any applications of the principles which he is studying, would be to deprive him of one of the essentials of sound training. Of even greater importance is the eminent desirability of having young men graduate "with the corners rubbed off," having come to maturity despite their incarceration in academic halls, having learned how to get on with their fellow men and knowing something of the lives and attitudes of workers other than university graduates. Only as students can young engineers really get to know the rank and file of the work forces with which they will be associated in their professional work. Graduation often raises a barrier which thereafter prevents entirely free intercourse with workers of other kinds.

Accordingly, undergraduate engineers are expected to make full use of the long vacations of the Canadian academic year. The unusual arrangement of this year may, in some measure, be due to this emphasis upon practical experience. The regular session extends from the end of September to the end of April, the two terms into which this period is divided, giving a total teaching period of about twenty five weeks. Allowing for the period of annual examinations, undergraduates have therefore about five months "Vacation"; they are expected to use this time profitably and well.

All students of civil, mining, mechanical and electrical engineering, mining geology and architecture at the University of Toronto must provide satisfactory evidence of having spent a specified period engaged in approved work before the completion of their undergraduate studies. The required periods vary up to six months,* even this figure being considerably less than the combined duration of the usual three vacations. The requirement is strictly enforced; quite a number of students have had to complete the required practical work after passing all their final examinations, before being admitted to their degrees. Despite the stipulated minimum period, all students are expected to use as many of their summer months as possible in obtaining outside experience, the value of which is repeatedly urged upon them. Occasionally, freshmen students will have obtained the required amount of practical experience before entering the university but even they are urged to use their vacations in continuing to broaden their experience.

Dealing with the practice in the Department of Civil Engineering (that in the other departments mentioned being similar), students are expected to obtain their own jobs. Only when direct application by an employer is made to

* Twelve months for Architecture, which is a five year course.

the department are the students told of specific jobs, and even in these cases, no single student is ever "given" a job; a number are advised of each opening, and the employer makes his own selection. Naturally every possible assistance is given to students. Lists of prospective employers are provided; certain information about contract awards is made available through copies of construction papers in the departmental library. Special lectures are given to freshmen students outlining the type of work they should seek, and the best methods of approach to adopt. But the actual procurement of the job is left to the individual himself (or herself!).

This is done in the firm belief that the experience of "selling one's services" is something well learned early in life. The value of the experience thus gained is attested to the writer almost every year by the sometimes ingenuous comments of freshmen after they have been rebuffed in a first attempt to obtain engineering employment (especially if they have to deal with efficient but possibly tactless women secretaries!). Repeatedly, young men have testified in later years to the value of thus being sent out on their own. The practice cannot always be followed; in mining work, for example, it is often difficult for young men to make contact individually with distant mines. In the case of universities located in small centres of population, some organized employment service is often necessary; Queen's University, Kingston, Ontario, follows this practice successfully. But in civil engineering work in a reasonably large city, the system described works well and undoubtedly benefits the young men concerned.

Each student has to notify the department as soon as he has employment, and if this is of "approved" type he is so advised. Students are encouraged to write, during the course of the summer, to the members of staff in charge of vacation work, the main object of this being to develop their capacity for self-expression by the writing of letters about matters of real interest to them. The writer has now a file of unusually interesting letters of this type, many of which show previously unsuspected talent and sometimes delightfully unconscious humour.

At the end of the summer, every student has to submit to the department an account of his work. Minimum requirements are laid down (in a comprehensive instruction sheet) as to length and content but only very rarely are these minima involved. Usually, and particularly in the senior year, the preparation of these "summer reports" proves to be an unusually satisfying experience, some students going to unexpected lengths in making their reports complete. The reports are carefully read, during the winter, by members of staff who have had construction experience. Suitable comments are made upon the contents and preparation of the reports, which are handed back to the students for retention as permanent records. Frequently senior students will have their three reports permanently bound. Some of the volumes thus produced, which it has been the writer's privilege to examine, will certainly prove to be of lifetime value and interest. One report is recalled which constituted a fairly complete photographic and written record of the main contracts carried out by a small construction company from its inception, incidental to the record of vacation experience of the student con-

cerned, a son of one of the founders of the firm. Another included many excellent freehand sketches and attractive wash drawings of construction operations usually thought of as prosaic in the extreme. Yet another included detailed economic analyses of the main construction operations witnessed and an independent study of local geological conditions, which later proved to be of unusual practical value.

As can be imagined, students of civil engineering frequently obtain their practical experience with general contractors. Other opportunities are provided by consulting engineers, municipal and provincial governmental offices, public utilities, telephone companies—practically every type of organization which normally employs civil engineers. Except in very unusual circumstances, students are urged to go with a different type of organization during each of their vacations in order to broaden their experiences and widen their interests. Not all students take this advice, which is not always welcomed by employers, but the writer has yet to hear of a single student who has not realized for himself the value of this variety of experience. Particularly valuable is work on construction projects on the staffs of resident engineers and contractors in different years; the insight which this provides into two sides of the same question, so to speak, is singularly useful.

For their first vacation period, students are strongly advised to take "pick and shovel jobs" unless they are able and qualified to obtain better positions. In this way they come to know at first hand something of the attitudes and problems of the "working men," knowledge that cannot easily be obtained in any other way. For all their work, students are encouraged to travel as far as practicable. Although perhaps not always appreciated by parents, this advice has evinced from students more appreciative comment—after it has been followed—than any other instruction about vacation work. The educative value of travel in itself is demonstrated remarkably by the personal development of some students. In war years, due to general man-power shortage, more extensive travel than usual has been possible. In one recent vacation, students of civil engineering at the University of Toronto were at work in each of the nine provinces of Canada, in Newfoundland, and in Labrador and one student achieved the enviable distinction of spending part of his summer on a special assignment in Baffin Land, far north of the Arctic Circle.

Corresponding details for the practice in the case of students of mining, mechanical and electrical engineering can readily be imagined. Work in these other fields is in somewhat more confined ranges than for civil engineering. Mines, industrial plants, and electrical plants and utilities provide respectively the majority of openings in these other branches. Apart only from the restriction of opportunities for travel, all other general comments still apply and even this exception is occasionally discounted, by mining students when working in far distant mines, by mechanical students voyaging on ships, and even by a group of electrical engineering students who have just returned from an interesting summer in the Northwest Territories of Canada, where they were engaged upon geophysical prospecting!

Students usually receive the regular rates of pay applicable to their work and in this way most of them are en-

abled, themselves, to finance a considerable part of their university education. Only in exceptional cases is it necessary for students to sacrifice the gaining of desirable experience in order to engage in other work yielding a higher financial return. Employers are generally required to certify as to the service of students with them but as the students occupy no specially privileged positions, detailed personnel records are not expected by the university, although they are sometimes received without solicitation.

It will be seen that, in essential features, the practice herein described is similar to the coöperative plan so successfully followed by the University of Cincinnati. Since it has not been developed along very formal lines, Canadian "vacation work" probably loses something by its informality and its lack of a proper title. It is, however, recognized and appreciated by all who have come into contact with it. It was this fact, together with certain other considerations, which influenced Canadian authorities, in the early period of the war, to disregard the appeals for accelerated engineering training, leaving the universities to carry on their normal schedules, although with greatly increased student enrollments and in the face of many operating difficulties of which the man-power shortage was and still is the most serious.

Despite its informal character, the administration of the vacation work at the University of Toronto naturally makes considerable claims upon the time of the members of the teaching staff responsible for its supervision since no special assistance is provided. All those concerned, however, feel that the results obtained well repay the time and effort demanded, the writer testifying to this from his experience in supervising this work in the Department of Civil Engineering (Municipal and Structural), of which Professor T. R. Loudon is head, having succeeded Dean C. R. Young in July 1943, to both of whom the writer records his thanks for support in the work described and for permission to submit this account for publication.

Post-War Plans for Coöperation Between Engineering Schools and the Aircraft Industry*

Assoc. Prof. of Mech. Eng. and Educational Supervisor, E.S.M.W.T.,

By A. S. LEVENS

University of California

Many aircraft corporations recognize the importance of developing highly capable engineers—especially for the post-war period when competition between them will mean the survival of the fittest. Several aircraft organizations have had, and are continuing in a stream-lined fashion, training programs for the development of their engineering personnel. Almost all companies have found it necessary to carry on upgrading programs in order to meet war production schedules. Plans for the effective carry-over of these programs, or the initiation of others, after the war should be given careful consideration now. The aircraft industry and the engineering schools must work hand in hand in the development of more effective engineering personnel.

A survey was conducted recently to learn what post-war plans for coöperation with engineering schools were being developed by the aircraft industry. A one-page questionnaire was mailed to sixty-four companies. Replies were received from 25. The following questions were raised:

1. Have you made or are you considering coöperative arrangements between faculties of engineering colleges and your company?
2. If you have, or are, how extensive, *i.e.*, vacation period employment for faculty; or exchanges, for possibly a year, between engineering faculty and company personnel?
3. Are you sponsoring or do you propose to sponsor fellowships for deserving undergraduate students?
4. Are you sponsoring or do you propose to sponsor fellowships for deserving graduate students?
5. To what extent are you sponsoring or to what extent do you propose to sponsor coöperative research programs for graduate students?
6. To what extent do you provide for or to what extent do you propose to provide for research grants to engineering schools?

A study of the replies revealed the following information:

Question 1:

(*a*) Three companies have made cooperative arrangements between engineering faculty and their organization.

(*b*) Twelve are considering the possibility of doing so. Of this group, *one* has made preliminary arrangements.

* Presented at the 52nd annual meeting, S.P.E.E. (Aeronautical), Cincinnati, June 22–25, 1944.

(*c*) Ten companies are not considering the possibility.

Question 2:

(*a*) Two officials stated: "We intend to follow the exchange practice."
(*b*) Two others believed that "less than one year is unsatisfactory."
(*c*) Ten favored vacation period employment.
(*d*) One uses faculty on a part-time basis during the regular college year.
(*e*) Ten made no comments.

Question 3:

(*a*) Eighteen companies said no.
(*b*) One stated "no plan to date, but considerable advanced training is offered free on company premises."
(*c*) One company has the plan in operation at present.
(*d*) Five companies are considering the possibility.

Question 4:

(*a*) Fourteen companies said no.
(*b*) One will sponsor when specific problem so warrants.
(*c*) One company has a plan in operation at present.
(*d*) One now assisting in a fellowship.
(*e*) Seven companies have taken the matter under consideration.
(*f*) One company believes it desirable to sponsor graduate training for certain key engineers.

Question 5:

(*a*) Twelve companies—"none."
(*b*) Four companies—"has been considered on a limited basis."
(*c*) Two companies—"have coöperated jointly with other firms."
(*d*) One company has a definite plan to encourage graduate students.
(*e*) One stated: "no coöperative research program—but we have coöperative students from General Motors Inst. and Antioch College."
(*f*) Two companies have helped with student research programs—*i.e.*, provided information in connection with thesis work.
(*g*) Another official stated "we intend to continue the practice for a limited number of projects in which we have an objective interest."
(*h*) Two companies made no comment.

Question 6:

(*a*) Thirteen companies said "none."
(*b*) Two companies have and are currently carrying on research programs at several schools.
(*c*) One states "has been considered on a limited basis."
(*d*) Two others have carried on programs jointly with other firms.
(*e*) Another official stated "one possible research endowment under consideration."
(*f*) One—considering.
(*g*) Five—no comments.

A summary of the above data shows that:

(1) 60 per cent of the companies have made or are considering plans for coöperative arrangements between engineering faculties and their organization.
(2) 24 per cent have made or are considering plans to sponsor undergraduate scholarships.
(3) 48 per cent have made or are considering plans to sponsor undergraduate fellowships.

(4) 40 per cent are sponsoring or plan to sponsor coöperative research programs for graduate students.

(5) 24 per cent provide for or plan to provide for research grants to engineering schools.

Interesting remarks were received from several corporations.

(*a*) From Curtiss-Wright Corporation, Propeller Division, Caldwell, New Jersey; "I believe that a lot can be accomplished by industry and colleges being partners in the training program for future engineers.

"We are interested in the development of future engineering courses and the academic problem. The closer industry gets to this picture the stronger will be the graduate engineer to meet the challenge. Fellowships, research grants, etc., have not been considered to date."

(*b*) From Hamilton Standard Propellers, East Hartford, Connecticut; "Have established and currently are conducting at a leading Eastern College a scholarship program for the training of approximately 135 women of college background in various phases of engineering."

(*c*) From Douglas Aircraft Company, Santa Monica, California; "Our practice is to employ at any of our six plants such faculty men as may be available under approximately the arrangements described below, limiting the number of them at any one location to a very few, perhaps just two or three at any one time.

"The duration of employment is normally one school term only; that is, approximately sixteen weeks. A given faculty man is, however, where justified, hired for another term after one or more terms back at teaching.

"Habitually, we accept men who are instructors in one or more subjects which we have recognized as appropriate to the curriculum for training engineers to work in our industry; that is, we do not take on under this particular plan office employees of the colleges or instructors in subjects which are vague in their relationship to our work.

"We always make in advance a definite schedule of the contacts that will be given to the man during his term of employment. This amounts to a program of rotating work assignments.

"The man comes to us with the understanding that his time will be spent principally in becoming acquainted with the work operations and procedures that a new graduate needs to understand better when beginning employment with us, and that productive effort on any job included in the program will be only a minor consideration.

"We have now accumulated considerable experience in the above type of 'indoctrination training.' We have been experimenting with it at our main plant in Santa Monica, for four or five years. El Segundo, Long Beach, and some of the midwest plants have also operated the plan in its various stages of evolution, with considerable success.

"For operation in the other direction, we would release suitably qualified engineers who are permanently on our payroll, so that case by case, on individual arrangement, they might put in one school term at a time on leave of absence from us to act as instructors.

"We are eager to do more along these various lines, and to persuade our associates in industry to undertake like effort."

(*d*) From Lockheed: "Several offers have been made to professors of

engineering colleges but, as yet, we have received no replies."

(*e*) From Consolidated Vultee: "Our complete program which was announced last June includes:

1. Undergraduate scholarships which are open to highly recommended engineering students who will have completed their junior year. In addition to the annual stipend of $250 (or tuition if higher) an opportunity to become oriented in the work of the aircraft industry will be provided through summer employment or preferably a full year's training and work experience before returning to the senior class.

2. Graduate fellowships which are open to highly recommended graduates of engineering, physics, mathematics, metallurgy, or chemistry, who are capable of undertaking advanced study and research in the field of aeronautics. The annual stipend is $750 plus tuition and nominal fees. Successful candidates will receive training for a year before entering upon graduate work.

3. Employment opportunities for engineering faculty during vacation periods.

4. Exchanges between engineering faculty and the Corporation's engineering personnel.

5. Graduate study and research for the Corporation's engineers. Members of the staff who have both the experience and training would be given an opportunity to return for a year or more to selected schools for advanced study and research.

A small group of fellowship and scholarship men are now in training. In addition a number of faculty men are employed at present. We also have several coöperative research projects in operation. The present manpower situation precludes the development of parts 4 and 5 of our program at this time."

(*f*) From Curtiss-Wright Research Laboratories; "We are deriving help from Montana State, M.I.T., and Cornell on several projects here. It is possible to carry on work at the universities under our supervision."

(*g*) From Stearman Aviation Inc.; "In general the proposed program sounds like a workable idea and as our organization grows we may be in a position to participate. Would appreciate being kept advised of the activity."

It is hoped that the information disclosed in this survey will be helpful in the development of post-war plans for coöperation between the aircraft industry and the engineering schools.

Development of Better Coöperative Relations Between Universities and the Railroads*

By R. E. DOUGHERTY

Vice President, New York Central System

On behalf of the members of the committee designated by the American Railway Engineering Association to report on the development of Coöperative Relations with Universities, I wish to express appreciation for the privilege and honor that you extend to them and to me of addressing you here today on a subject that is of substantial importance to the railroads and to the universities.

The Board of Directors of the American Railway Engineering Association in 1940 reëstablished this committee which had been previously discontinued. We have since functioned under the very able and energetic leadership of Elmer T. Howson, Vice President and Western Editor of the Railway Age. In addition to the Chairman, the membership includes one representative of industry, a former railroad man, six men from the colleges and thirteen railroad officers.

Railroad executives, without exception, have expressed great interest in this work. The interest of the universities has been most gratifying. Expressions of opinion from the university men have in some instances been decidedly critical of the past of the railroads and skeptical of the future. This line of thought, coupled with the glamour of certain competing forms of transportation, and other reasons, whatever they may be, has been specifically manifested by a growing lack of interest of students in the railroad courses and the discontinuance by the universities of certain railroad subjects which some of us had the privilege of taking.

It would seem, therefore, that the first approach should be some discussion of the past of the railroads with thoughts as to the future, especially as I am sure that some of you, at least before the war, had the idea that the railroads were on the down grade and perhaps on the way out as a major transportation agency.

The railroads had some bitter experiences during World War I and were confronted with the responsibility for certain factors that were beyond their control. There was such a sudden increase of business for which neither the Army, the Navy nor industry had made adequate provision from their own viewpoints that the cars became storehouses. There were also inadequate means for loading and unloading, in addition to troubles that can be attributed directly to the railroads themselves. These difficulties were particularly aggravated at the ports where congestion was further stimulated by the inability of shipp

* Presented at the 52nd Annual Meeting, S.P.E.E. (Coöperative) Cincinnati, June 22–25, 1944.

to take the consignments. This, coupled with the exceedingly adverse weather conditions of the winter of 1917–1918, created a vast amount of difficulty.

After the roads were restored to private control in 1920, railroad officers immediately went to work to study the deficiencies of their properties and to benefit by the experience gathered from the acid tests of war.

Between 1923 and 1942, inclusive, the roads spent about $11,000,000,000 for new equipment and all other facilities that go to make up a railroad plant. A vast amount of elimination of grade crossing work was developed with the public authorities.

With the coming of the depression and the decline of business, many of us having to do with these expenditures wondered whether or not our judgment had been justified. Any question of that sort has been resolved by the experience as a sequel to World War II. With the approach of World War II there were many who were cynical as to the ability of the railroads to function under private management and who advocated the return of government ownership. The wisdom of saner minds prevailed and now, I dare say, there are but few whose opinions we value who will disagree that the record has amply substantiated the faith of railroad officers as to the ability of the roads to function properly.

In spite of the fact that railroad men believe that they can consider certain phases of the performance with substantial pride, nevertheless we are fully conscious of all deficiencies and have no thought that the roads themselves are solely responsible for the satisfactory features of the performance. The Army and Navy learned a lot from the last war and have exhibited rare good judgment in the selection of storage, holding and reconsignment stations and other similar facilities of a reservoir nature which have proved lifesavers under conditions of heavy traffic. Due recognition as to assistance in the handling of the tremendous volume of traffic imposed upon the roads must be given to the sympathetic and patient coöperation of shippers and receivers and the public generally.

One of the most cruel phases of the years of depression was the fact that boys graduating from universities, filled with hope and ambition and well equipped, found insufficient place in industry and I dare say that that difficulty applied not only to the railroads but to almost every form of industry. In the twenties the total employment on the roads averaged about 1,800,000. This was reduced in the thirties to about 1,000,000 and was less than that figure in the years 1933 and 1938, and now approximates 1,300,000.

I am optimistic as to the future and have faith that the railroads will continue to serve as the major transportation agency for any period of time which it is possible for any of us to foresee although the last twenty years have more than amply demonstrated the fact that but little omnipotent wisdom has been given to man to outguess the future, even for periods of time that are frequently expressed in months and not in years.

We realize fully that much of the intensive competition of the pre-war period will be revived and probably accentuated. The railroads have been studying their own problems most intensively. The Association of American Railroads has had a committee of nearly fifty executive officers working for two years on the Study of Transportation and taking all phases of it

into account: technical research, operation, traffic, finance, economic studies of commodities and their possibilities, consolidations and coördinations, personnel, public relations, competing agencies and every other phase of railroad activity which may be a determining factor in the future.

Similarly, most of the roads, certainly the larger systems, have their own research organizations which are studying their individual problems.

In all of this it seems that if the country is prosperous the volume of business will be there for the railroads but if the country is not prosperous we will all suffer together.

It is hoped that there will be some more realistic attitude taken toward competing agencies and their public subsidies. This becomes particularly pertinent when we realize that aviation is subsidized probably to the extent of 70 or 75 per cent in so far as the capital investment necessary to enable the planes to fly may be concerned. I dare say that most of you came through the Cincinnati Union Terminal. The expenditure assumed by seven railroads to make that terminal possible was approximately $42,000,000, the obligations for which were assumed by the participating railroads. In contrast, La Guardia Field in New York City cost approximately the same amount of money, financed entirely by Federal and City funds, and unquestionably is far from self-supporting. In fact I do not believe there is an important airport in the country that is self-supporting.

While it is difficult of analysis and perhaps argumentative, the users of the highways similarly seem to us to assume only about 40 per cent of the total cost necessary for them to operate. However, in contrast, the pipeline is a pretty self-reliant sort of a fellow and generally carries his own burden, although he too should be under the same general form of control as the railroads. Waterway operations, particularly those of the artificial type, probably bear less than 30 or 40 per cent of the total carrying charges. Waterways should be subjected not only to proper tolls but new projects should be required to pass the test of public convenience and necessity before some such quasi-judicial body as the Interstate Commerce Commission in similar fashion to the requirements for any new projected line of railroad. It is hoped that public transportation policies of the future will more nearly require that all forms of transportation shall be self-supporting. If that is done I have no fear for the ability of the railroads to hold their own.

I am one of those who believe that the railroads should remain not only railroads as such but should be permitted to become transportation agencies voluntarily engaging in other forms of transportation, air, highway, pipeline and waterway, as the future may determine.

There are many problems and factors too numerous to mention here which may be controlling as to the future of the railroads. That may seem to be a statement of uncertainty but I do not consider that any more uncertainty applies to the future of the railroads than applies to the future of any other form of transportation and in fact the future of the country. If I were not hopeful I certainly would not be here today.

The experiences of the depression, coupled with the war and whatever other factors anyone may see fit to ascribe, have created situations such as that which the New York Central faces

in the not far distant future. Within the next ten years there will be over 500 positions of responsibility and importance where the present incumbents will retire on account of having reached the age of 70. This number may be increased by physical disability and incapacity requiring the retirement of others prematurely. I dare say that similar situations prevail on many other roads.

There will be no lack of capable men that may be required for the next decade to fill any of the important positions but I am much concerned with the lack of the younger men in their twenties and early thirties who, in the normal course of events, would fill these executive positions of importance in the coming generation. I realize, however, that there are many men in the Army, particularly in the Military Railway Service, in Africa, Italy, India and probably in France, who are receiving a post-graduate education that no university or railroad organization could furnish and many of them who come back will still be young men.

In filling executive positions there is no substitute for the experience which time provides even to capable men but there must be a supply of well-trained young men to follow.

I approach consideration of the future of the engineer on the railroads, and have always considered it, from an exceedingly broad standpoint. In other words, I do not believe his functions should be limited to the determination of stresses and strains and stability and with field parties, construction and similar activities. When a project once is authorized its execution can be developed along well established lines. One of the most important fields for the engineer, however, is in determining the economics and wisdom of the project and I believe one of his greatest opportunities lies in the field of economics which is allied to operation. For many years engineers have been given assignments of this character in constantly increasing magnitude and number and many an operating vice president has an engineering assistant helping him analyze his problems, many of them having to do exclusively with operation. The right kind of an engineer should have opportunity to enter the operating department. Traffic officers have shown increasing interest in the engineer, particularly in the location and development of the physical plants of industry. The real estate officer finds the engineer of value to him in his various problems, including development, appraisals, assessments, etc. In fact there is an increasingly important field in valuation, depreciation, etc., from the real estate, rate-making and income tax standpoints for the engineer with C.P.A. inclinations. Our insurance and fire protection problems have, for years, been under the jurisdiction of engineers. There is a field for the engineer in the purchasing department, particularly having to do with the purchase of materials for construction of track, structures and equipment.

Many railroads have extensive problems having to do with the development of coal, oil and timber lands. Analytical studies involving not only immediate operation but consolidation and coördination are frequently developed by the engineering analyst in conjunction with the operating, traffic and legal officers.

The last century saw the completion of most of the major lines of railroad and since 1900 probably the only lines of importance to be constructed have been the Chicago, Milwaukee, St. Paul

and Pacific, the Virginian, the Florida East Coast and certain other extensions in Florida, the Western Pacific, the Denver and Salt Lake, the Spokane, Portland and Seattle, certain sections of the Santa Fe and various lines in Texas.

Beginning about 1900 and continuing to the depression there was a tremendous amount of expansion and reconstruction of existing plant. Such improvements have given the railroads a plant capable of carrying the greatest business in their history.

There are many improvements under consideration that are a sequel to studies of increases in speed and improvement of freight and passenger service. Probably the greatest change in railroad plant in the next generation will have to do with changes in motive power and other equipment, particularly the former, although there will be many changes in track and supporting facilities to expedite operation. The present indications are that the Federal Government, States and Municipalities will initiate a very substantial amount of elimination of grade crossing work, reconstruction of existing highway-railroad crossings and similar work which will involve coöperation of the railroads.

The railroads are giving concentrated attention to improved steam power, including steam turbines and other variations. There has been substantial use of diesels which many roads will extend. The roads with heavy density of traffic have been studying electrification or its extension. It may be that the gas turbine will be a factor in the future. Much of this will also involve considerations that will be of considerable moment to the coal and petroleum industries.

The problems of research on a railroad are practically unlimited but it will be up to the engineer to take care that his imagination does not run away with his economics.

While the railroads in the past may have seemed to display insufficient interest in the engineer, we might review the number of railroad executive officers who have had engineering training and background. A canvass of the railroads a few years ago showed that 35 per cent of the executive officers had engineering education and a more immediate review indicates that at least 40 railroad officers holding such positions as Chairman of the Board, President, Vice President and other chief executive officers, have come from among the engineers. There are at present between 15 and 20 railroad presidents and chairmen of boards who have had engineering training.

While the interest has not been as well coördinated as it should have been, many railroad officers in the past have contacted the universities in an effort to interest graduates.

As a matter of fact, if I may be pardoned for interjecting a personal note, my own engagement with the New York Central Railroad was the direct sequel of an inquiry from W. J. Wilgus, then Chief Engineer, to Professor W. H. Burr, head of the civil engineering department of Columbia University, asking if any of Professor Burr's graduates would be interested in employment by the New York Central.

Many college graduates have become dissatisfied with the early opportunity and progress offered by the railroads and have engaged in other fields of endeavor with subsequent expressions of regret.

It may be of interest to learn something of the requirements for which

railroad officers look in engaging men and perhaps more particularly in the considerations when they come to advance them for promotion to positions of substantial responsibility.

It must be remembered that a technical education or any other education can only be one factor in determining a man's success. The boy from the engineering school will frequently find himself in competition with boys who have had to battle their way from a high school education or possibly less. Many of the old successful locating and construction engineers originating in the last century were without college training and in fact many of those men looked with great condescension on the college graduate.

Within the last six months I have discussed at length with our chief engineering and maintenance officers the factors that go to make up a man's success and have given consideration to some possible plan of rating in judging these characteristics, although no rating system can be a substitute for immediate knowledge of the man. It may seem easy to state just what these characteristics may be but an attempt at careful analysis is something different.

After much study it seems to my close associates and to me that the characteristics of these men may be divided into three broad groups—Executive and Administrative, Professional Ability and Personal Considerations, with a number of subdivisions which time does not permit me to discuss.

We have had a great deal of discussion as to whether, under the head of Professional Ability, the qualification of technical ability and not technical education should prevail and possibly, when considering a man at the end of a period of ten or twenty years, the fact that he had a technical education should be completely subservient to the fact that he is technically capable, regardless of how he has acquired his knowledge. This expression of thought even came from several men with engineering education. Personally I do not think that there can be any complete substitute for a technical education although in any analysis of rating characteristics it may show an importance of 10 per cent or less. I have great faith in the education of an engineer as a means of developing powers of analysis and orderly thinking.

It would seem that the universities should plan their work so as to take full cognizance of the fact that a technical education is not the sole key to success in any industry. There is many a poor kid who is educated beyond his intelligence who cannot begin to compete with a boy who has started without the benefit of an education but who has applied himself with a superabundance of the other natural characteristics which go to make up a successful man in any walk of life.

The only approach which can be made is to consider two men with the same native characteristics, thus starting with a common premise. In such a case the man with a technical education should have a substantial advantage at least for the first ten or fifteen years and it should accrue throughout his career. The education of a sensible and ambitious man ends only with life itself.

One great industrialist recently somewhat deprecated the value of a college education and believed that a boy should get an early start as a mechanic and thus gain an advantage of several years in his industrial life. While I fully believe that there are

many boys who are wasting their time in college, nevertheless I am not in accord with any such blanket stipulation.

In anticipation of this meeting I have discussed with about a dozen of our principal officers in the engineering, maintenance of way and electrical and mechanical departments this question of the educational needs of men for railroad service. We cannot presume to tell you how this best can be developed—all we can do is to endeavor to coöperate with you in the hope that we may be of at least minor assistance in considering the problem.

Most of our men are inclined toward the idea of a four-year course for engineers and for a longer course only if so closely identified with actual training in industry as to practically constitute a year or more of experience. That statement, of course, would not include the specialists who are candidates for advanced degrees.

Most of us believe that the universities should earnestly endeavor to place their men to advantage in the summer vacation period. Boys taking engineering courses should be given to understand that they are there for a serious purpose and if they want to go to college merely seeking four years of easy life they had better take something else. We likewise believe that their vacation periods should be utilized for the advancement of their education through practical channels.

Many of our men believe that university graduates are sadly lacking in their powers of expression and their ability to use the English language and to present a report concisely and efficiently. This is probably and primarily a deficiency in pre-college training. It also seems that there are too many boys who enter college without any definite ideas as to what they want. Furthermore there are too many who might better become mechanics and get into active service rather than to go to college. However, it seems as though that might better be a function of improved vocational training in the preparatory or high schools.

The education of an engineer for the railroads should not only include training along the basic and well established principles but should include education along broad comprehensive transportation lines with consideration given to organization work, the general principles of operation, economics, management, accounting, finance and at least general consideration of competing agencies.

The railroads have given more consideration to the employment of engineering students than many of the university men believe. A number of roads, including my own, have had apprenticeship courses coming under the jurisdiction of the equipment department.

In 1941, the New York Central embarked on a plan to engage engineering students for the summer vacation period, preferably beginning with the sophomore year but even extending it to the vacation period at the end of the freshman year. For several years we employed from 50 to 75 of these boys from about 30 different institutions. The war, unfortunately, put an end to any such activity. Unless some other plan is meanwhile presented it would be my idea that some such program should be revived at the conclusion of the war. Many other roads have adopted plans for training of engineering prospects fully as effective and possibly more so than that of the New York Central.

I have discussed the question of

coöperative education with many of my associates among the executive officers and they all seem much interested in the development of a proper plan. It would seem that there is opportunity for coöperation with the railroads in the training of men for not only the engineering, maintenance of way and equipment departments, but for operation and possibly coöperation with the business schools for traffic and accounting departments.

On the other hand, I dare say that one difficulty may be that there will be too many schools thus engaged just as there is probably too much transportation of all kinds in this country and probably wasteful, inefficient competition of that sort should be considered and reduced to a minimum.

The question also arises as to assurance to be given against unemployment. In that connection I am afraid that after graduation the boys from the engineering schools will have to take their chances with the rest of the organization. There would be nothing more fatal to their position in any organization than to set them apart as privileged characters entirely immune from the vicissitudes of financial difficulty. On the other hand I cannot imagine any railroad officer releasing a brilliant prospect without a struggle.

For any coöperative course to be effective the railroads might have to make some arrangement with the colleges in connection with coöperative education so that a boy once having started on his course can be assured that he would be able to complete it, but after he graduates he will have to rely on his own personal ability to hold his place in the sun.

I sincerely hope that our committee of the American Railway Engineering Association will be able to present to the railroads, as a most important post-war contribution, some plan of coöperation with the universities which will be of benefit to the universities and the railroads and, perhaps even more important, of benefit to the boys themselves.

Patents and the Chemical Engineer*

By ERASTUS S. ALLEN

Patent Attorney

In reviewing the growth of our country, I suppose everyone will admit that its growth has occurred under at least a fiction that it was free competition which was the incentive for men to put forth their best energies and efforts—that it was this freedom of opportunity to achieve the goals which represented success which caused, as far as our knowledge of history goes, this unapproached era of industrial growth and development. Men have thought pretty generally: "the human being is naturally lazy and indolent—unless he has to work he won't. Competition is therefore good." Now whether competition is good or not, it is my thesis that, in an era of free competition, unified control of prices inevitably results in most industries. This same era has therefore been an era in which the wastefulness of price competition has been so apparent in most large industries that agreements to control it or practices having a like monopolistic result have naturally grown up. Adam Smith and John Stuart Mill, whose theories were thought to be almost definite laws, did not have opportunities to observe more than the initial phases of the results of free competition. They never had enough data to determine whether or not price control was a good thing. I use the word "monopoly," as we used to use the word "trusts," to signify the private control of an industry, tending to keep those engaged in it on a profit basis and to dissuade others from entering it. It has been assumed that it is not a good thing. But whether this type of monopoly is good or bad—I am not prepared to debate—as long as I make my point that it is, according to my theory, the natural result of an era of free competition.

When inter-connecting agreements, price fixing, and the like began to be ostracized because of an aggressive attorney general's department under Theodore Roosevelt, corporations began to think of legal ways of affecting monopolies. They found in patents a legal monopoly and a legal basis for price fixing and other controls of competition.

A patent is a privilege given by statute and grants a legal monopoly for seventeen years for the thing patented. The basis for patents is Sec. 8, Article 1, of the Constitution of the United States: "Congress has power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective discoveries."

For more than a hundred and fifty years our Supreme Courts have considered the monopoly granted by a patent a good thing—coinciding with the generally accepted view that in the

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freely competitive field of originating new ideas it was right to grant this incentive to men to protect them in the exploiting of what they had contributed toward industrial progress.

But it became apparent, after the trust busting phase of federal attack on our industrial progress had resulted in strict interpretation of the Anti-trust laws and prosecutions under them, that patents and the legal monopolies granted by them were being used to create this same monopolistic trend in industrial development about which there had been such a hue and cry, the assumption being that it was a bad thing.

And so in its urge to placate the common man in his inner resentment at the monotony of working at a machine unit the resulting product of which machine had little to show as to his contribution to it, the Supreme Court in recent years began to think up more and more ways to knock out the monopolistic possibilities of patent combinations. In other words, patents have been considered by the Courts from the point of view of their social implications.

For a period of almost ten years in all but two cases for which there was some special reason, as I will explain later, as to one of them, the Supreme Court has invalidated all patents which have come before it. This was on the general theory that patents, since they had been used to bring about combinations in industry, must themselves be bad things.

The reasons given by the Court have often had nice theoretical explanations but most of the decisions have had behind them, I think, a hostility toward patents based on the belief that the owners of the patents had exceeded the bounds of the monopolies granted under the patents. In other words, the patent laws had been used to create monopolies greater than the monopolies which the members of the Supreme Court thought were reasonable. There are a number of legal statutory defenses against suits on patents and the Supreme Court thought up some other ones which elaborated and expanded those defenses.

You might wonder why the patent laws were not changed to avoid the so-called "evils." Many changes were suggested but every time Congress thought it had its teeth in something that could be improved in the patent laws, there appeared at the hearings—not the large operators, but the little fellows who had established small businesses based on patents. The truth is that the large industrial groups do not need patents to keep them in business. With them they are only a means to an end, but with the little fellow it is different. His business may depend entirely on his patent monopoly. Every time Congress prepared to limit the possibilities of the use of patents by large industrial groups it was the little fellow who was hit. And so Congress did nothing. But the Supreme Court took up the cudgel with renewed vigor.

Judge Learned Hand—a circuit Judge in the Second Circuit, in a decision May, 1942 in *Picard v. United Aircraft Corporation,* 128 F. (2d) 632—clearly explained the judicial trend of the Supreme Court. He said: "We cannot, moreover, ignore the fact that the Supreme Court, whose word is final, has for a decade or more shown an increasing disposition to raise the standard of originality necessary for a patent. In this we recognize 'a pronounced new doctrinal trend' which it is our 'duty' cautiously to be sure, to follow—not to resist."

Probably that man who has had the most influence in bringing patents into disrepute was Thurman Arnold. He was assistant attorney general and for a number of years he not only aided in the prosecution of all litigation against the owners of patents, but he spent a good part of his time making speeches against them. In a way he achieved the reputation of "patent buster" just as Theodore Roosevelt made a name for himself as "trust buster."

Thurman Arnold's policy, as shown by a congressional investigation in connection with Arnold's attack on the William Dzus patent on an aeroplane cowl fastener, became thoroughly aired in the newspapers and it was generally concluded that Mr. Arnold was so interested in theory that he too obviously overlooked facts. In answer to questions put to him by members of the Congressional Patent Committee as to whether certain facts were shown to be present in the particular case, Mr. Arnold said that he did not know whether certain facts existed or not, but that under the patent system they might very well exist. However, Senator Clark of Idaho showed that Arnold did not hesitate to confuse the possibility and the fact. He said:

"Somewhere in this record Mr. Arnold reported that the Dzus fastener was the only fastener which the Army and Navy approved. That is not the fact.

Mr. Kane: It is not the fact.

Senator Clark: That is the nub of Mr. Arnold's case."

Thurman Arnold was stirring up a lot of trouble asserting that what might be—had been. He has now been elevated to the bench of the Court of Appeals of the District of Columbia where he is writing decisions which reflect his attitude on patents.

I would like to quote from a recent decision of Judge Arnold because it sums up his ideas about the evils of patents. The decision was in *Pitts v. Coe,* 60 U.S.P.Q. 226, and involved an invention in the research department of the Teletype Company, a wholly owned subsidiary of Western Electric. These ideas reflect with considerable accuracy the trend of the reactionary element toward our established institutions such as patents.

"In other words, patents are not intended as a reward for a highly skilled scientist who completes the final step in a technique, standing on the shoulders of others who have gone before him. By the same token they are not intended as a reward for the collective achievement of a corporate research organization. Today routine experimentation in the great corporate laboratories can produce results beyond the imagination of twenty years ago. But such contributions to industrial art are more often than not the step by step progress of an entire group, not the achievement of an individual. Such an advance is the product not of inventive ability but of the financial resources and organizing ability of those who operate the laboratories. The practice of requiring the expert employees of research organizations to assign in advance all their future patent rights to the organization, itself reflects the respective contributions of the organization and the individual to these so-called inventions. The 'inventor' is paid only a salary, he gets no royalties, he has no property rights in the improvements which he helps to create.

"To give patents for such routine experimentations on a vast scale is to use the patent law to reward capital investment, and create monopolies for corporate organizers instead of men of inventive genius.

"The corporate research laboratory of today has given us the greatest invention of modern times, the knowledge of

how to invent. Under a disorganized system of invention a hundred men would hunt for the needle in the haystack, the prize going to the successful finder while the efforts of the others served only to scatter the hay in all directions. Organized invention has changed the entire process. Each man is given a section of the hay to search. The man who finds the needle shows no more 'genius' and no more ability than the others who are searching different portions of the haystack."

The general idea of the Supreme Court's theory of confining more and more strictly the monopoly granted by a patent is well explained in its decision in the Masonite case decided in May 1942. I will quote it: "Since patents are priviliges restrictive of free economy rights which Congress has attached to them must be strictly construed so as not to derogate from general law beyond necessary requirements of patent statute."

In January, 1944, in a decision in the Mercoid case, the doctrine of contributory infringement was knocked out. Patent monopolies up until that time had as a basis for all working arrangements some reliance on this doctrine. It was assumed that any person who assisted another to infringe a patent had some measure of responsibility himself. The court (speaking through Mr. Justice Douglas) said:

"Leeds & Catlin v. Victor" (that case was decided in 1909)—"is authority for the conclusion that he who sells an unpatented part of a combination patent for use in the assembled machine may be guilty of contributory infringement. The protection which the Court in that case extended to the phonograph record, which was an unpatented part of the patented phonograph, is in substance inconsistent with the view we have expressed in this case. The rule of the Leeds & Catlin case must no longer prevail."

This is one of the rare cases in our legal history where the Supreme Court has flatly reversed itself instead of drawing distinctions based on special facts.

Had Congress changed the patent laws it could have outlined restrictions in the use of patents. The Supreme Court cannot do this in an open and direct way. What it does is to say: "You have used your patent in a way which conflicts with what we understand to be the laws controlling our system of free enterprise—you have tended to create a monopoly outside your patent grant; therefore your patent cannot be enforced."

When you hear people argue that the Supreme Court cannot make laws that is a legal fiction. The effect is the same. For example, to hold a patent invalid is in effect the same as refusing to enforce it, which the Supreme Court has repeatedly done in recent years.

There is in the various decisions of the Supreme Court in this recent Mercoid case an interesting revelation of the confusion which we lawyers must admit exists in our efforts to construe the law of patents. Justice Douglas wrote the opinion. Justice Roberts wrote a dissenting opinion. Justice Reed joined in Roberts' dissent. Justice Frankfurter wrote a dissenting opinion. Justice Jackson also wrote a dissenting opinion and Justice Black wrote an assenting opinion dissenting with Justice Frankfurter. Justice Black explained the purpose of his decision as follows: "I find it necessary to add a few remarks in order that silence may not be understood as acquiescence in the views expressed in the dissenting opinion of Mr. Justice

Frankfurter." Then he said: "It seems to me that the judicial error of discussing abstract questions is slight compared to the error of interpreting legislative enactments on the basis of a court's preconceived views on 'morals and ethics.' "

It seems regrettably to be the case that suits for protection of patents in the Supreme Court have degenerated into a forum for the airing of personal disagreements between certain of the Justices as to social trends, with the poor patent lost in the debate.

Mr. Justice Black and three other members of the Court appear to be heart and soul "agin" patents. Mr. Justice Frankfurter appears to think the Supreme Court has gone far enough. He seems to be beginning to appreciate the conservative wisdom of a hundred and fifty years of judicial thought by our Supreme Courts on the subject of patents.

In one of the latest decisions of the Supreme Court, *Goodyear Tire v. Ray-O-Vac*, decided Feb. 28, 1944, after the years of uniform hostility to patents, the Court has sustained a patent on putting a metal shell around a dry battery to prevent it from swelling—probably the most obvious non-inventive patent that had been before it for years.

Mr. Justice Black, with whom Justices Douglas, Murphy and Jackson concurred, said as to the invention:

> "Antiquarians tell us that the use of solid containers to hold liquids predated the dawn of written history."
>
> "It is impossible for me to believe that Congress intended to grant monopoly privileges to persons who do no more than apply knowledge which has for centuries been the universal possession of all the earth's people—even those of the most primitive civilians."

With four judges still openly hostile to patents and four judges leaning toward a more conservative view, the ninth and newest, Judge Rutledge, holds the balance of power. In the Ray-O-Vac case he seems to have been won over by the more conservative group. It is significant also, I think, that the basis for the majority decision in this recent Ray-O-Vac case is the social implications of the particular patent involved, rather than a consideration of abstract questions of inventive novelty over what had gone before.

I have dwelt in these few remarks on the present trends in judicial decision as to patents because, after all, a patent is worth no more than the force which enables it to be brought into effect.

There is no question but that our Courts, and also many other governmental personnel, are concerned more greatly with the social implications of causes that come before them than they are with the abstract rights which are asserted and denied. This may be a healthy trend. I do not attempt to take sides on this point, but it overlooks the fact that Courts are chiefly set up to decide controversies which the parties cannot adjust for themselves, and that our business and social activities are based on what we suppose to be rules under which we may play the game. To have the referee decide whether there has been offside play with the idea of punishing one side or the other for reasons having nothing to do with the particular decision, makes it tough for the football coach and the players.

But as to patents for inventions and their ultimate protection, I personally have no great fear. Essentially they are right from the point of view of our

economic life and sound as bases for continued progress. What is and what is not invention is appropriately a matter which should ultimately be decided by a contest in which both sides are represented.

What we should do is continue to take out patents for inventions and continue to promote the industrial development of patented inventions by giving the patentee the sole right to do so, for a period of years. The Supreme Court, starting fresh with what appears to have been an impossible standard of what is an invention or what is a valid patent, has, we think, begun to realize that they have started to kill the goose that has laid a number of golden eggs.

Our clients have not ceased to take out patents on meritorious advances made by them. We tell them although it would be hard to sustain their patents in the Courts, that this is a trend, and that it is bound to swing around because the trend is unsound.

The day has probably passed when owners of patents can hedge themselves with protective contracts demanding of their licenses courses of business which subjugates them outside of the precise field occupied by the patent. A concern with a patent on a new movie projector can probably never more require that it be used only with film obtained from a designated source, where the film is not patented of itself, nor can by any roundabuot ways accomplish the same end.

But this does not operate against free enterprise. Patents are a necessity for free enterprise because without them the small manufacturer has little chance in the competitive field against the large manufacturer.

Thus the pendulum of interpretive decision seems to be swinging backward so that now anything can happen. Is a horizon of the future where "anything can happen" necessarily a dark one? As far as patents are concerned, they have always been gambles. We merely have a new kind of roulette wheel on which we play them, and we patent lawyers are not quite as sure of the rules to be prescribed by the croupiers as the game is being played.

It seems to me that to you men, most of whom are interested in the teaching of young people, there should be much satisfaction in a future where "anything can happen" and that for young people to be urged to strive toward the final objective of having something to say in what does happen is not an unworthy objective.

Science or Transits

By E. H. CAMERON

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To maintain a sensible curricular balance between theory and practice has always been the professor's toughest problem. He needs, and often requests, advice from engineers in the consulting offices and the field as he considers this problem. In the discussion of the subject of postwar plans for Civil Engineering Education, I should therefore like to submit the following points:

Point One

Engineering colleges cannot afford to allot time to instruction in the use of surveying instruments; such time is needed for science, particularly mathematics.

I realize that ghosts of the past will rise to object to this statement: shades of early members of the Am. Soc. C. E., who proudly wore membership pins on which a surveyor's level was engraved. Also, turning over in his grave—some folks might imagine—would be John A. Roebling, America's greatest bridge engineer of the last century, the Chief Engineer of Brooklyn Bridge.

For wasn't Roebling running a transit at the time of the accident that resulted in his death? If he thought it proper to make his own survey for the Brooklyn tower, while tremendous problems in its design and construction awaited his decision, surely he would be the first to emphasize the importance of good lines and grades, and the necessity of college training in such work. Or, would he?

Let us invite Roebling back to the land of the living, and, while agreeing that good surveys are essential, ask him whether he would take college time for instruction in this subject today.

So let us assume that ultra-efficient John A. Roebling has miraculously returned to us, after a celestial preinduction course in the vast advances in engineering knowledge that have been made since his death. When he attains the position of Chief Engineer of today's greatest bridge in the world, will he engage personally in the surveying operations required for its location? Will he again send his son to Rensselaer Polytechnic Institute, to spend time in acquiring dexterity in the use of a transit and level? Rather, will he not say:

"It is neither honest nor efficient to spend college time for such instruction!

"God knows, this son of mine needs every hour available to absorb properly the tremendous volume of the knowledge of science, particularly mathematics, that a 1945 engineer must know. Stick to your science, Professor!

"Transits and levels? There are proficient instructors in the use of such apparatus in the secondary schools, and on every construction job."

Point Two

The colleges should make huge cuts in the time now allotted to the teaching of drafting.

Let's ask John Roebling about this, too. But watch out! He was reputed to be a bitterly tough fighter when things got out of balance, endangering efficiency. Steer him clear of the acres of college drafting rooms, unless science laboratories have proportionately greater area.

We marvel today at Roebling's brilliant use of the meager science of his day to attain results which men now respect, as they apply modern scientific methods to similar problems. Viewing the fascinating field of science, awaiting the exploration of his reincarnated son at a modern Rensselaer, wouldn't the elder Roebling say: "Some knowledge of drafting methods my son must get here. But not at the expense of instruction in science!"

I wish that I might say that John A. Roebling would also deplore that too-common deficiency in engineering educational schools: the lack of successful results in the teaching of English. But Roebling was poor in English, too. His reports make fascinating reading, true; but this is in spite of their poor composition. In fairness to him, we must remember that English was not Roebling's native tongue.

Point Three

Somehow the colleges must find time to teach the boys how to express themselves properly. Near the top of the postwar curriculum of engineering colleges should be the subject of *English.*

On the Derivation of Certain Formulas*

By NEIL LITTLE

Assistant Professor of Engineering Mechanics, Purdue University

In most texts, and I presume in most classes, the derivation of the formula for the relation between bending moment at a section of a beam and the shear at that section, follow essentially the following pattern. An element of the beam, of differential length, is taken as a free body, a moment equation about one end of the element is written and eventually there results, some such equation as

$$dM = V dx - \frac{w(dx)^2}{2}.$$

The term $\frac{w(dx)^2}{2}$ is then dropped because it is "a differential of higher order" or it "is very small and can be neglected," or something to that effect.

The present author feels that this is psychologically bad. A knowledge of differentials in general, and order of differentials in particular is not part and parcel of the understanding of the sophomore or junior engineering student. So the student doesn't understand, he knows that he doesn't understand, the teacher knows that he doesn't understand and the student knows that the teacher knows that he doesn't understand. I don't believe I need elaborate on the psychology of such a situation, or of going ahead with a derivation under such circumstances.

I should like to propose this variation. Use Δx and ΔM instead of dx and dM, where Δx and ΔM have the customary meanings as used in the Calculus. We then arrive at the equation

$$\Delta M = V \Delta x - \frac{w(\Delta x)^2}{2}.$$

Divide by Δx,

$$\frac{\Delta M}{\Delta x} = V - \frac{w(\Delta x)}{2}.$$

Let Δx approach zero as a limit, in which case $\frac{\Delta M}{\Delta x}$ approaches the derivative of M with respect to x (by definition of the derivative) and $\frac{w(\Delta x)}{2}$ approaches zero. Hence we have

$$\frac{dM}{dx} = V.$$

This method uses only the most basic and fundamental ideas of the Calculus. If there are things in here that the student does not understand or cannot remember then one might easily argue that it is high time he came to an understanding of them or recalled them.

* Presented at the 52nd annual meeting S.P.E.E. (Mechanics), Cincinnati, June 22–25, 1944.

The method is applicable to any derivation in which a differential element is being used. Two such derivations that come to mind are those for belt friction $\frac{T_1}{T_2}=e^{f/b}$ and the normal acceleration of a point in curvilinear motion, $a_n=\frac{v^2}{r}$. In both of these a more sound psychological situation can be created by using a method similar to the one above.

New Members

HAYES, JOHN M., Associate Structural Engineer, Tennessee Valley Authority, Knoxville, Tenn. N. W. Dougherty, A. T. Grander.

HUBBARD, NOEL, Registrar, Missouri School of Mines and Metallurgy, Rolla, Mo. C. L. Wilson, A. C. Callen.

KIRK, FRANCIS S., Asst. Supervisor-Educational Officer, Ed. Unit, U. S. Merchant Marine Cadet Corps, Kings Point, N. Y. R. C. Sundquist, L. B. Guelpa.

LABENSKI, JOHN J., Research Assistant, M.E., The Pennsylvania State College, State College, Pa. V. E. Howes, M. G. Mochel.

LEWIS, FRED A., Professor and Head, Dept. of Mathematics, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

LITTLE, NEIL, Assistant Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. Seibert Fairman, A. P. Poorman.

STEPHENS, HOWARD J., Associate Professor of General Engineering, Iowa State College, Ames, Iowa. Frank Kerekes, H. J. Gilkey.

STERLING, GUSTAVO R., Dean, School of Engineering, University of Havana, Havana, Cuba. J. S. Thompson, F. L. Bishop.

THOMPSON, HENRY C., Assistant Professor of Engineering Drawing, Purdue University, Lafayette, Ind. Justus Rising, R. W. Lindley.

WEBB, WILLIAM S., Professor and Head, Dept. of Physics, University of Kentucky, Lexington, Ky. D. V. Terrell, J. G. Potter.

WHEELER, WAYNE J., Supervisor of Time Study. Delco Products Div., General Motors Corp., 544 Corona Avenue, Dayton 9, Ohio. C. A. Brown, R. H. Spahr.

233 new members this year.

Technology As Action and Science*

By NICHOLAS M. OBOUKHOFF

Research Professor, Oklahoma Agricultural and Mechanical College

1. Composite Character of Technological Science

Since one of the main purposes of this paper is to find the place which the science of technology occupies among other sciences, it would not be amiss to begin with the characteristics of the former and its relations to the latter. The boundaries are not sharply defined: they rather constitute marginal fields with overlappings and interpenetrations on both sides: the one where technological science borders on the physical group and the other where it comes in contact with social disciplines. Indulging in imagery, one might say that the science of technology originates at a calm and serene altitude, springing, as it were, from the pure sources of physical science; then it flows down fertile valleys of its own heritage and finally empties itself into a turbulent and stormy sea of human social life.

Since technology *considered as action* is a complex of different components, in other words, of many functions (technical, social, economic, etc.), it extends from a strictly technical sphere into a realm of social relations. A science and an education pertaining to this expanded field should logically and adequately be of the same scope and range to comprise all those functions and serve as their rational or reasonable foundation.

Science of technology as a complex of knowledges underlying manifold technological activities is heterogeneous or, rather, *should be* such, but its social component has not yet been sufficiently recognized and developed. Likewise, technological education is, with a few exceptions, under a spell of traditional tenets which recognize physical science as the sole factor in shaping its foundations.

Living realities call for a widening of the field of technological science in accordance with the criterion set up by a complex of technological functions. This synoptic view is forcibly suggested by actualities of technology viewed as action and implies that some kind of balance between the maximum technical efficiency, on the one side, and economic and other social requirements, on the other, is aimed at and somehow practically established. In order that this delicate function of balancing should be performed as consciously and conscientiously as it is possible and therefore adequately—or at least approaching adequacy—not as an outcome of conflicts between semi-articulate group psychologies—knowledge of technology should also include

* This paper is the recently revised abstract of the one read by Nicholas M. Oboukhoff before the Fifth International Congress for the Unity of Science held September 3–9, 1939, at Harvard University, under the title "Empirico-Logical and Teleological Factors in Engineering."

familiarity with socio-economic factors of modern society, its functions, trends and movements.

It would be in agreement with facts to state that practical and even purposive theoretical attempts have been made and sustained, with some amount of success, to rationalize technology from a standpoint of more satisfactory social relations within its realm—sociology supplying incidentally one component of the efforts. The writer is aware that, for example, Cooley's theory of "primary groups" has been given an industrial turn and consistently applied to improve social relations as between employers and employees while others have made use of the ideas advanced by Sidney and Beatrice Webb in their work, "Industrial Democracy," and have achieved the same purpose. The origin of "Industrial Sociology" as a new discipline arising from coöperative efforts of engineers, sociologists and economists is visualized. It is contemplated as a coördination of the corresponding components of knowledge mutually influencing and affecting each of these fields. It is admitted that this is rather a vision; yet the signs of the time point in the direction of its realization.

Through *technological* applications, physical science is given an *additional* social significance and recognition while more practical weight is eventually imparted to social science. Also a stronger demand for more exact methods can hardly fail to affect social sciences as they are attracted and to an extent drawn into the field of technology. Thus the science of technology becomes *another* link between physical and social disciplines contributing to a *firmer cohesion and stronger unity of science.*

It is thought that the following digression would be conducive to the clarification of the foregoing paragraph.

Toward the end of the 19th century the development of science has shown the additional process, then in its incipient stage, but in full swing in the 20th century: There have appeared new disciplines whose structure has been composite or synthetic covering two or even more different fields of knowledge previously considered as separated by sharp lines of demarcation, but which have now become objects of mutual correlation and deeper interpenetration. Let us mention and slightly analyze some of them:

Geography, for instance, presents the aspects of both physical and social science: as the former, it is grounded in geodesy, geology, paleontology, ecology, etc., while, as the latter, it has its foundation in anthropology, ethnology, economics, history, etc. In this connection Elysée Reclus should be remembered as the greatest geographer of the second half of the 19th century who had started the science of geography on the road to a synthesis and cohesion of its multifarious components.

Physical chemistry, already in existence in the later years of the 19th century, has, since the advent of the quantum theory, reached the stage of mutual interpenetration of physics and chemistry that compels some philosophers of science to consider them as one single discipline.

The creation of biochemistry and biophysics is one of the recent achievements in this movement towards a closer cohesion of science: biology, on the one side, and chemistry and physics respectively, on the other, have been tied up to form two new disciplines of synthetic character. Both are impor-

tant in the study of the biological zone of the atmosphere.

Also ecology is now becoming a discipline where biology and sociology are destined to establish some kind of mutual association, with the concept of environment being extended to include society or its elements and man.

These examples exhibit the *chain* unity of science in the sense that the mentioned disciplines function as links and bridge over the sharp lines of demarcation which the older classifications of sciences assumed to exist between them as, for instance, in Comte's doctrine of their mutual irreducibility.

The philosophy of the unity of science has many aspects. As early as the beginning of the 19th century Claude Henri Saint-Simon had already realized their importance and with unrelaxed persistence turned them over and over again in his mind.*

It is hoped that the introduction of a consideration based on the writer's proposition about the presence of the chain characteristic in the relations between sciences would, in some degree, strengthen the doctrine of the unity of science itself.

2. Factors of Value and Purpose in Technology

Taking up the matter in a more concrete sense, and also from a standpoint of worth, one can see how strictly technological values such as maximum efficiency of operation, excellence in achieving new technical results, etc., are confronted with economic values of small expense, of most economic design and operation, best competitive price of a commodity, worth of former investments, etc. These heterogeneous values are often in conflict with each other, so that technology has for its task to work out a compromise to establish a balance and coördinate them. Another example of conflicting values may arise in a form involving problems of the value of an individual, of his dignity, safety, health, comfort, and conveniences, versus either technological values or economic interests or both. As an outcome of this situation, we have safety and health regulations, ordinances, laws, etc., and also the origin of a new discipline of safety engineering together with sanitary engineering. Sometimes it occurs that the more urgent value of a nation interferes with technology as in the case of national defense. Also, technology may be affected by social conflicts when group values (interests) oppose each other, as in the case of capital and labor relations. Relations of value influence technology in a large way, so that social axiology is of a practical importance.

Regarded as action, technology has its main objectives and goals in the maintenance, development, expansion and *betterment* of *material* culture of society in so far as physical things or objects and technological operations, such as extracting, raising, growing, manufacturing, assembling, testing, transferring, arranging, building, etc., are concerned. If it is also specified that material culture should be considered, understood and estimated from a standpoint of contemporary society, a *social* character of *present day* technology with its potentialities, actualities and commitments appears and looms much more impressive and important than a mere logical interpretation of the

* Nicholas M. Oboukhoff, *Relation of Technology to Humanism in Goethe's "Faust" and in the works of Saint-Simon;* pp. 658–663. The Journal of Engineering Education, Vol. 34, No. 10, June 1944.

concept of material culture would suggest.

3. Empirico-Logical Factors in Technology

Great achievements of science come up first as basic foundations on which an edifice of engineering has been erected; mathematics and physical sciences are usually understood to be chief contributors to a success of technology. Hopeful expectations recently aroused in the minds of progressive engineers by quantum and wave mechanics, by electronics, as well as tensor analysis, are wholly justifiable in view of successful attempts at their applications in technology. It is a matter of fact and common knowledge that the familiar deductive, inductive and empirical methods have been used in extending scientific results into the field of technology. Yet that is only one part of the story. It would be erroneous and unfair to belittle the role played by technology in the common creative function performed by technology and science together. Both have their distinctive *main* functions equally important and mutually nonreplaceable; one is *naturalistic,* another *social.*

It is easy to see that *technology transfers, so to speak, natural phenomena discovered and investigated by science into the realm of society; it socializes nature. An adaptation of natural phenomena to social environment is in itself an important task; it is substantially supplemented by making them socially usable and useful in a more or less permanent way.* This implies that special apparatus and installations have to be worked out in conjunction with economic and other social requirements as explained in sections 1 and 2. Problems of size and scale, form and shape, of *mass* production, and *mass* operation, those of steadiness and reliability, sturdiness and safety, economy, ruggedness and permanency, etc., become vexed questions all the more that *they require solutions in their entirety and also in their relations to each other. The science of technology is as much synthetic as it is analytic.*

Technology is not a mere "particularization" of general principles and propositions found or established by exact science; it is not a mere appendant to it, whose problems are just "matter of course" trivialities. Technology possesses creative synthetic power of its own, as it has tasks of its own, too. Years, even decades, usually elapse after the enunciation of a scientific naturalistic proposition before its materialization in the midst of society takes place. The principles of electromagnetism and electrodynamics were discovered and established by science in the first half of the nineteenth century, but it took decades to make them socially usable and useful and the credit goes primarily to technology. Creative speculative investigations by Maxwell, and no less ingenious experimentations by Hertz, in the second half of the nineteenth century laid a basis for the science of electromagnetic waves, but the creative work of its application and adaptation to social uses was brought to completion by Marconi and his forerunners—Branly, Lodge, Popoff and Tesla * not earlier than the first years of the twentieth century. The list of similar examples could be made as long as one would desire it to be.

Indeed, the road of technology is arduous and adventurous all the more that science even now *does not supply* technology with theoretical and ex-

* The order is alphabetical.

perimental methods for solving *all* of its technical problems. Science itself is not omniscient. Then technology has to start on its own and try to solve a problem or problems by any means. The difference is this: science can wait for solutions of vexed problems, but technology cannot often afford to step aside and say: "Let us wait"; it often *has* to do something about a problem or problems *in some manner*. Then *a synthetic judgment, plausible* proposition, postulation, intuition, common sense, etc., whatever it may be termed, is of specific help to technology *in all its phases*: technical, economic and social, in general, *as well as in synthesizing effects of different factors as suggested in the foregoing.*

After having made a survey of all—if possible—data, facts, and considerations, with anticipated circumstances in view, an apparently most probable conclusion is reached or a plausible proposition is formed to be subsequently tested and verified by deduction, experimentation, practical experience and common sense. If the same procedure is repeated several or many times to find an optimum or even better solution, it can be termed a method of successive approximations. Sometimes a group of plausible propositions is assumed and verified. Uncertainty involved is estimated and then taken care of by "margin or factor of safety," which means that a structure, apparatus, installation, etc., should be designed, built or manufactured stronger, more efficient, safer than actual operation and service would require it to be. In addition to the method of synthetic judgments or plausible propositions, also that of empirical correlations between serial magnitudes is widely and efficiently used in technology. It is significant that those methods were primarily proposed by John Stuart Mill for use in the realm of "moral" (social) sciences.

The implications are not of a nature to cast a shadow on the science of technology. On the contrary, it possesses powerful means for the verification of anticipated conclusions and propositions, on the one hand, and the construction of correlations between serial magnitudes, on the other. It is an ordered and extremely self-critical knowledge obtained by means of specially organized technique: mental and material. Technology is a science in its own birthright.

4. Epistemological Implications in Technology

Two opposite poles in a variety of epistemological doctrines stand out as the extremes: The Platonic structure of knowledge built primarily on the principles of generality, stability, permanence—the doctrine of ideas, on the one hand, and the pragmatic standpoint with its emphasis on the perceptional, concrete, particular and individual—the radical empiricism of William James and the "Grammar of Science" of Karl Pearson, on the other.

In its less original, but never-the-less very important part, the science of technology uses and applies general laws, propositions, postulates, hypotheses borrowed from physical and social sciences. There the universal reigns supreme. Yet, where and when technology starts on its own because other sciences are not in a position to obtain and convey *all* necessary knowledge, as explained before, its pragmatic nature becomes obvious, to the extent that synthetic judgments and empirical correlation are *sometimes* no more than pragmatic beliefs, especially if adequate empirical material or time or both are

lacking to put judgments to a thorough test. Technology boldly invades the fields unexplored or not sufficiently explored by other sciences, and, in so doing, it is fully justified for development would be sluggish or even arrested if technology had to wait for an accumulation of adequate data in *urgent* cases. Of course it is realized that a penalty for this daring may appear in a form of wider margin of safety and higher costs while the principle of "unavoidable necessity" (*force majeure*) intereferes in and with technology in a large way. This pragmatic aspect of technology is as important as one based on fundamental sciences. Technology in a broad sense is a science for and of action, which *implies considerations of value* no less than of knowledge.

The epistemological dualism in technological science can hardly be denied. Technology appears as a scientific edifice built in two different styles: Platonic and Pragmatic. It may lack epistemological elegance; yet it is and will be proficient and efficient because of this dualism—at least at the present time and in the near future.

Birthday of an Octogenarian*

Scores of the friends of Professor Dugald C. Jackson, head of the Electrical Engineering Department at M.I.T. from 1907 to 1935, gathered at the Engineers Club in the evening of February 13 to celebrate the eightieth anniversary of his birth. After a social half-hour in the Library, the company filled the Assembly Hall at the birthday banquet. The speakers included President Compton, who presided; Dean Barker of Columbia University; President Sah of the National University of Amoy, China; Dean Moreland, Professor Hazen, and Professor C. E. Tucker. Mr. Gerard Swope and Dr. Frank B. Jewett, on the original list of speakers, were not able to attend. 174 letters of greeting and appreciation were received.

In his opening remarks President Compton compared the meeting to a family gathering of old friends and complimented Mrs. Jackson for the contributions she had made to the social life of the Institute. He expressed the belief that Professor Jackson had discovered the fountain of youth and had continued after retirement to do the things he wanted to do and which he had done all his life. He characterized Dr. Jackson as a man of constructive ideas and progressive vision.

In his response Professor Jackson parried the various eulogies applied to him throughout the evening by quoting an observation of Josh Billings that "Flattery is like Cologne water which one smells of and enjoys but does not swallow." He expressed his appreciation of the individual comments of all the speakers, especially the idea that the successful engineering educator must be at once a teacher and a practising engineer. He said that he was particularly pleased that Mrs. Jackson had received her share of the greetings, and in terms of Wordsworth referred to her as "The sweetest thing that ever grew beside a human door."

* Taken from March 1945 issue of *The Technology Review.*

New Members

ABBOTT, WILTON R., Assistant Professor of Electrical Engineering, Iowa State College, Ames, Iowa. J. D. Ryder, J. E. Dean.

HORSCH, ALFRED C., Vice-President, Pitman Publishing Co., 2 West 45th St., New York 10, N. Y. R. F. Neale, Alexander Klemin.

LANDER, L. C., Chairman, Dept. of Industrial Engineering, General Motors Institute, Flint, Mich. C. A. Brown, R. H. Spahr.

LAYING, FRANK R., Chief Engineer, Bessemer and Lake Erie Co., Greenville, Pa. J. B. Babcock, R. B. Kittredge.

LONG, EDWARD L., Assistant in Physics, Rensselaer Polytechnic Inst., Troy, N. Y. G. K. Palsgrove, R. A. Wyant.

NEALE, RUSSELL F., President, Pitman Publishing Co., 2 West 45th St., New York 10, N. Y. E. E. Booher, Alexander Klemin.

RADER, LOUIS T., Director and Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. L. E. Grinter, H. T. Heald.

WHITE, JOHN F., Director of Admissions, Coördinator of Veterans, Illinois Institute of Technology, Chicago, Ill. L. E. Grinter, H. T. Heald.

WINNE, HARRY A., Vice President, General Electric Co., Schenectady, N. Y. A. R. Stevenson, E. S. Lee.

Guide to the Evaluation of Educational Experiences in the Armed Services

The American Council on Education has just completed a study of training and experience in the armed services. This report, Guide to the Evaluation of Educational Experiences in the Armed Services, is issued in loose-leaf form suitable for binding in a standard 6x9 folder. The handbook contains various types of information of assistance to school and college administrators in the evaluation of training and experience in the armed services such as, 1, outlines of the services of the U. S. Armed Forces Institute; 2, recommendations as to the unit value of high school correspondence courses offered by the Institute; 3, interpretation summaries of the examination results furnished by the Institute; 4, sample procedures with reference to academic credit for service adopted by various types of institutions; and 5, outlines of and recommendations concerning the wide variety of service courses and service schools. The handbook may be secured from G. P. Tuttle, 363 Administration Building, W., Urbana, Ill.; price $3.00.

Engineers' Council for Professional Development

Vocational guidance aid to returning veterans who may look to engineering as a peacetime career and announcement of a plan for accrediting educational programs of the technical institute type are among the current activities noted in the Twelfth Annual Report.

According to the report of the Committee on Student Selection and Guidance, "to serve these veterans adequately will require all the facilities at our command and will involve a considerable expansion of our subcommittee structure. . . . Veterans are gravitating naturally to facilities existent in their own localities. . . . Guidance, particularly of an informational character, should be made available to high-school principals and guidance officers. Informational material should be given concerning the profession, the requirements and responsibilities, colleges and Veterans Administration centers where engineering tests are given, and a list of local subcommittees of this committee. . . . A pilot survey of some two hundred schools in New York State and several in Canada reveals that these schools need and want this information. The fact that there are 25,000 high schools in the United States and 2,000 in Canada gives an idea of the scope of the problem.

The measurement and guidance proj-

ect of the committee which is being carried on under the direction of the Carnegie Foundation for the Advancement of Teaching, is directed to the development of a battery of tests to aid the proper selection of students for engineering. During the first year of operation of the project eleven colleges of engineering coöperated in the work. Fifteen institutions in the United States and Canada have evidenced interest, and their inclusion in the projects awaits official sanction of the Advisory Committee. It is planned to extend the services offered by the project, as the Carnegie Foundation feels that the tests are now sufficiently developed to warrant a considerably wider application.

Accreditation of the curricula of engineering colleges in the United States, which has been the major activity of the Committee on Engineering Schools for many years, was held to a minimum last year because "the committee believes that engineering colleges cannot be fairly judged while operating under war conditions."

The Subcommittee on Technical Institutes completed an inclusive study of the present status of education of the technical-institute type in April, 1944, and a new subcommittee has been appointed to bridge over the war period and to formulate plans for accrediting educational programs of the technical-institute type.

A revised "Reading List for Junior Engineers" was a significant contribution of the Committee on Professional Training during the year.

Principal developments during the year affecting employment conditions of engineers in the United States and Canada are covered in a report of a special committee.

What E.C.P.D. can do to make the program of professional development more effective and what the constituent organizations did during the year toward furthering the objectives of E.C.P.D. are covered in brief reports submitted by representatives of these organizations.

The objectives of E.C.P.D. are to coördinate and promote efforts to attain higher standards of education and practice, greater solidarity of the engineering profession, and greater effectiveness in dealing with technical, economic, and social problems.

The headquarters of E.C.P.D. are maintained in the Engineering Societies Building, 25–33 West 39th Street, New York 18, N. Y. Copies of the Twelfth Annual Report may be obtained by addressing the Secretary, R. L. Sackett, or The Engineering Institute of Canada, 2050 Mansfield Street, Montreal 2, Canada.

Necrology

HARRY FREDERICK BENNETT, District Engineer of the Department of Public Works of Canada at London, Ontario, died suddenly on January 31, 1945. He was born May 6, 1888, at Saint John, New Brunswick, and graduated from the University of New Brunswick in 1908 with the degree of B.Sc. in Civil Engineering, the Ketchum Silver Medal and the Fredericton City Gold Medal. In the same year he entered the Canadian public service as an Assistant Engineer with the Department of Public Works of Canada at Saint John, N. B. In 1924 he went to the Halifax District as Senior Assistant Engineer. In 1930 he was promoted to the position of District Engineer at Sault Ste. Marie, Ontario, and in 1936 he became District Engineer of the larger district at London, Ontario, where he remained until his death. During the 1st World War he served overseas with the 9th Overseas Siege Battery, and the 48th Howitzer Battery, 2nd Brigade, C.F.A. He was a very active member of the Engineering Institute of Canada, serving as Councillor in 1930, and since 1939 as Chairman of the Committee on the Training and Welfare of the Young Engineer. Representing the Engineering Institute, he served also on the Committee on Student Selection and Guidance of the Engineers' Council for Professional Development at New York. He was also a member of the Associations of Professional Engineers in the Provinces of New Brunswick, Nova Scotia and Ontario. Because of his great interest in the advancement of engineering education he became a member of the S.P.E.E. in April, 1940.

HENRY J. KESNER, Professor of Civil Engineering at the University of Nebraska, died in Lincoln on February 10, 1945.

Mr. Kesner was born in Ontario, Canada in 1883. He received degrees of B.A., B.S. in C.E., and the C.E. degree from the University of Colorado in 1905, 1907, and 1911, respectively. His professional experience consisted of an intermingling of the activities of student, teacher and practitioner in the broad fields of Civil Engineering. His particular interest, however, was in the field of structural engineering. He taught successively at the University of Minnesota, University of California, Purdue University, Armour Institute of Technology, and at the University of Nebraska from 1923 to the date of his death.

He was responsible for the design of many bridges in Indiana, Colorado and Illinois. His contributions to the technical papers of the American Society of Civil Engineers, and engineering Journals were many and varied. He had membership in American Society of Civil Engineers, Society for Promotion of Engineering Education, Phi Beta Kappa, Sigma Xi, Tau Beta Pi, Theta Tau, and Sigma Tau. His strength in teaching was of the very highest order.

Mechanical Engineering Division

The launching of a *Heat Power News and Views* is a new step for the Heat Power and Mechanical Laboratory Sections of the Mechanical Engineering Division of the Society for the Promotion of Engineering Education. Its value and success will depend to a large extent upon the interest and activity of the members of the Society engaged in teaching Heat Power subjects.

The publication should serve a very useful purpose. Short topics which do not warrant presentation as a paper at the Annual Meeting can be brought to the attention of interested members through the publication. New course material, new methods of presenting old ideas or difficult topics, may be presented. New experiments or acquisition of new laboratory equipment should be suitable subjects to publish. Acquisition of the latest charts, tables and diagrams can be facilitated by announcements in the publication. Many other worth-while contributions can be rendered through the pages of the publication. It is the hope that many will contribute articles, notices, problems, etc., from time to time, whether they be short or long.

The Mechanical Engineering Division is fortunate in having Professor E. N. Kemler of Purdue University accept the responsibility of editing and publishing the publication. Professor Kemler always accomplishes a well done job and we can count on the *Heat Power News and Views* being a success under his guidance.

It is not asking too much of interested members of the Mechanical Engineering Division to contribute to the pages of the *Heat Power News and Views.*

F. L. SCHWARTZ,
Chairman, Heat Power Committee,
S.P.E.E.

College Notes

Colorado School of Mines.—During the 1945 spring term the intensive course in English is being offered for the second time. This course requires eight hours a day for fifteen weeks and precedes the foreign students' enrollment in the engineering curricula at the School of Mines. Research and development of the program began nearly two years ago under the direction of Professor H. M. Crain. Methods used include those devised by the Army, the Navy, and other agencies, as well as new techniques which are the result of experimentation at the Colorado School of Mines. Visual equipment, including still projection and motion pictures, and sound reproducing equipment, both disk and magnetic wire recorders, are used throughout the course. The first offering of the course was in the summer of 1944. The present offering will be repeated in the 1945 Summer Session, and, thereafter, the course will be offered only in the summer. Professor Leo Jason, of the Department of Modern Languages, and Professor E. G. Fisher, of the Department of English, are collaborating in the research and organization of the course and are supervising instruction.

The war-accelerated program of three terms a year has been discontinued. The Summer Session for 1945, followed by the two regular semesters, has been resumed. With the return to the normal Summer Session six weeks, beginning May 28 and ending July 7, will be devoted to full-time field courses in mining, geology, petroleum production and plane surveying, and full-time laboratory courses in hydrometallurgy and petroleum refining, followed by a nine-week engineering summer session offering a full program of freshman, sophomore, and junior engineering subjects.

University of Rochester.—Lieut. Col. John H. Belknap, at present with the Army Air Forces in Washington, has been appointed chairman of the newly established Division of Engineering. Col. Belknap will occupy the Yates Professorship of Engineering. He will also serve as Professor of Electrical Engineering. Under the new Division of Engineering, a four-year course in electrical engineering will be introduced in addition to the present accredited programs in chemical and mechanical engineering.

A Foundation for Industrial Research has been established at the **University of Wichita** as the result of $450,000 contributed by local business and industry. Started by voluntary subscriptions of $100,000 each from Beech Aircraft Corporation and Cessna Aircraft Company, the fund is expected to reach the half million mark soon. The program calls for expenditure of the original fund within the next ten years, thus providing a substantial annual sum which will be used in the main to supplement the present research staff and to improve laboratory facilities.

As President W. M. Jardine points out, Wichita is one of the nation's vital war production areas and following the war will face the huge task of maintaining employment in its readjustment to peace-time economy. Many sub-contractors and scientific men who came to the city to engage in war work wish to remain—some to carry on with industries already established and others to engage in new fields of enterprise. Many problems involving industrial research have arisen in these industries. The primary purpose of the Foundation is to maintain facilities and personnel for research and testing work in this connection.

Applied and pure research will be conducted in aeronautics, engineering, agriculture, chemistry, physics, geology, petroleum, and marketing analysis and outlets. Fellowships and scholarshpis will be established whereby outstanding students may engage in graduate study pertinent to the work of the Foundation. Research on problems submitted to the Foundation will be undertaken for industrial firms at their expense, with all results being turned over to the requesting concern.

President Jardine views the Foundation for Industrial Research as a step forward in integrated education—coöperation between business, industry and the University. Management of the Foundation is vested in a nine-man Board of Governors appointed by the Board of Regents; six from industry, two from the Board of Regents, and the President of the University who is automatically a member.

A Reply from Industry to the Colleges*

By M. M. BORING, A. R. STEVENSON, JR., AND K. B. McEACHRON, JR.
General Electric Company

I. A Glance at the Record

The importance of engineering education to the future of industry in America has been strikingly emphasized during the war years. Remarkable achievements in education have paved the way for the miracles of industrial production that have characterized this war.

The colleges and universities of the country have altered their programs to a remarkable degree to fit the requirements of the armed forces. In many instances these changes have led to new and improved methods of teaching which can be readily applied to education for peacetime engineering.

II. The Job Ahead

In the concern of the nation for the problems of reconversion of industry there is often little recognition of the significant reconversion job which the colleges face. We are particularly aware of its importance and magnitude because of our close contact with college graduates and our interest in education generally.

In recent months colleges have been asking the assistance of industry in planning postwar college curricula. Although few men in industry have ever taught in a college or university, many have had considerable contact with the college graduates who are hired annually by industrial concerns. Industry is rightly realizing the importance of education in engineering and welcomes an opportunity to discharge a part of its responsibility in this field by coöperating with the colleges in studying postwar curricula.

A. *The Accelerated Schedule*

There is grave danger that some colleges and the public generally may believe that an accelerated college program is superior to the prewar college schedule. Experience with those graduates employed in the past two years leads us to believe that the engineering graduate of an accelerated program is limited, compared with his prewar predecessor, in his ability to analyze engineering problems from fundamentals.

Students enter college much earlier than usual with the result that few of them are sufficiently mature or emotionally adjusted for the college experience. Elimination of most free time in the accelerated schedule has drastically reduced the effectiveness of instruction. Those who advocate continuing the accelerated program fail to recognize the loss to the national culture and the lack of all-around ability of engi-

* This paper has been written in response to a number of specific requests addressed to us from the colleges asking advice and criticism about proposed engineering curricula. This paper was presented to the S.P.E.E. committee on Relations with Industry and endorsed by the committee on March 13, 1945.

neering graduates under such a program.

B. *The Immediate Need*

Some educators and industrial representatives will see in the reconversion facing the colleges an unusual opportunity to make sweeping changes. Although needed changes should be introduced wherever possible, we should recognize that the primary emphasis is upon the necessity of returning to basic college curricula as rapidly as possible. Except for men returning from the services, a negligible number of engineers will be available to industry in the next few years. Nothing should delay an immediate return to regular college programs in order that this barren period may be as brief as humanly possible. Any changes that are to be made, therefore, must not delay this return.

III. Primary Emphases in the Curriculum

A. *Basic Engineering Fundamentals*

Engineering education in college must be concerned with engineering fundamentals rather than specialized design. The war has shown us that radically new designs must usually be based on the fundamentals of engineering rather than on previous design. It is far more important therefore for the college graduate to have a thorough understanding of all the fundamentals underlying engineering rather than detailed knowledge of any specific design or device. For example, a thorough understanding of such fundamentals as Newton's laws is of far more value in the solution of general mechanics problems than a host of specialized formulae.

Many will take exception to these beliefs, pointing out that widespread acceptance of them would lead to a single unified undergraduate engineering curriculum. At least one educational institution has done exactly that with success. In the General Electric Company little recognition is ever taken of the branch of engineering in which a person was graduated as the requirements of any electrical manufacturer so combine the mechanical, electrical and chemical fields as to be almost inseparable.

1. *The Case for Specialization*

It has been argued in the past that the colleges must provide specialized training rather than fundamental understanding because many small companies do not have educational programs which will assist the graduate in obtaining practical experience. It is our belief that it is no more practical to graduate full-fledged engineers from college than practicing doctors from medical school. Perhaps because the materials with which the doctor deals are irreplaceable, we have recognized the importance of interneship earlier in this profession than in engineering. It is nonetheless essential to the successful training of outstanding engineers.

Some attempt has been made to recognize such an interneship or apprenticeship by the provision of some states, notably New York, for an "Engineer-in-Training" level of the professional engineers. Such an apprenticeship means that a small company without even a single good engineer who is capable of educating newer men cannot hope to supply this need directly from the colleges but must employ from some other concern an older engineer who has had both education and practical experience. In other words, there is no substitute for ap-

prenticeship in the best sense of the word in engineering as well as in mechanical trades.

B. *Stimulation of Ingenuity*

A second equally important consideration which must be borne in mind in discussing college curricula is the stimulation of the native ingenuity of undergraduates. During the war period students have not usually been encouraged to think for themselves in the rush of absorbing detailed knowledge in a rather limited field. We believe that emphasis on engineering fundamentals and ingenuity go hand-in-hand to develop a successful engineer. To encourage the ingenious student further, the curricula of the future should provide opportunity for the design and construction of ingenious electrical and mechanical devices. The educational purpose will be better satisfied and more such projects can be provided by the colleges if such devices are small and simple rather than large and complex. At least one college in the southwest has scheduled this type of a design class with the additional condition that only students who have demonstrated a certain minimum of ingenuity and who strongly desire to take such a class will be enrolled. Students in the past have often been required to take college design courses regardless of their interest in electrical design. Such design classes have seldom involved actual physical design and development of ingenious devices. We believe that the plans for classes such as that suggested above will stimulate interest in design and development to an unusual degree.

C. *The Extent of Electronics*

It is hardly possible today to discuss engineering curricula without touching upon the subject of electronics. The special needs of the war have stimulated an unusual interest in this subject. The need for technically trained personnel acquainted with electronics principles has resulted in the inclusion in most engineering curricula of a number of courses specifically designed to answer such a need.

Although training in electronics during the prewar years was probably inadequate to meet industrial demands, this recent emphasis on education in electronics exaggerates the relative importance of this phase of the electrical industry in the postwar period. In the General Electric Company, for example, estimates of postwar business indicate that the apparatus lines will still be ten times greater than the communications business. We are therefore vitally interested in maintaining a proper ratio between education provided by the colleges along these two directions.

In general, it is preferable to give the student engineer a broad concept of the complete frequency spectrum emphasizing particularly the fundamentals underlying the operation of devices at any frequency. Thus whenever need arises for a fundamental understanding of high frequency problems, the basic principles are already well understood. In addition to presenting proper technical material, the college must also be prepared to stress the relative importance of communications compared with the other branches of engineering.

D. *Preparation for Citizenship*

Many articles have appeared in the technical press in recent months emphasizing the importance of the nontechnical portion of an engineering undergraduate curriculum. There is no

doubt that recognition of the more cultural and liberal phases of education has been too long ignored in engineering colleges. Here also, however, there is some reason to advocate caution in the extent to which the nontechnical part is increased. It is beyond question that some engineers adequately prepared technically have found great difficulty in adjusting themselves to industry and developing an active participation in society and community life as a result of their lack of understanding and appreciation of nonengineering subjects. Great care must be experienced in the way in which such subjects are taught if maximum benefit is to be derived. In his book "On Education," * Sir Richard Livingstone is particularly emphatic concerning the periods in a person's life when such material can be most usefully absorbed.

> That is, you cannot study fruitfully liberal subjects, among them philosophy and politics, unless you know something of life. On the other hand, there are subjects, such as mathematics, of which a boy or undergraduate is fully capable of understanding, even if he knows nothing outside the walls of his home, school, or university. For whereas politics and ethics are concrete, mathematics is purely abstract and theoretic and does not spring from life or need experience of life to illuminate or correct it.

We believe that the principal purpose of such subjects as English, public speaking and art of dealing with others in engineering curricula should be to acquaint the undergraduate with the importance of these subjects and to develop his appreciation for them as essential to his future career even as an engineer. Too often in the past an attempt has been made to get across a certain minimum of information rather than an attitude of mind. All of these liberal subjects should be taught by a person who has a sincere appreciation for the role of the engineer in society and who can fully understand the engineering point of view. It is only such leadership that can stimulate and impress the young engineering student with the importance and value of such liberal material.

For example, much of the student's antipathy for English can be traced, we believe, to a lack of understanding of the engineering student by his English professor. This point is particularly well illustrated by a recent article by A. M. Buchan entitled "English in Basic Army Courses." † This same article described the effect of encouraging the professor of liberal subjects to appreciate the relation of engineering to society in these words:

> The professors learn from their students. An interest in technical subjects has been born, and the old literary bias against them is disappearing. A notion of culture as an attitude assumed towards any subject, technical or philosophical, rather than as familiarity with certain arts and books begins to appear, and the teacher of Wordsworth or Thoreau finds himself engaged, and happily, in discussing baking methods or the development of alloys. For the teacher of speech, too, there can be a realization that the orderly description of a coke oven is just as valuable practice as an argument on Fascism.

We would also suggest that in spite of the modern tendency to depreciate the value of foreign languages in the curricula, there is a real value in the study and mastery of languages other than our own. The study of history,

* Used with permission of the publishers, the Macmillan Company.

† This article appears in the April, 1944 issue of the JOURNAL OF ENGINEERING EDUCATION.

economics, and civics should not be neglected but in these also emphasis should be placed on developing an attitude of mind in the student which will make him aware of the engineer's responsibility as a member of society and the large part which he should play in such society.

IV. Adult Education for Engineering Graduates

Recognition of the importance of adult education has increased greatly in the past few years. A quotation from Sir Richard Livingstone mentioned earlier suggests that intensive study of cultural or liberal subjects such as philosophy and politics is properly postponed beyond graduation and should be reserved for a later period in the engineer's life when he has had some experience outside the school. There has been a strong tendency for the college graduate to consider his education completed.

The proper attitude toward education as a process of continual growth should be stressed again and again to the undergraduate. He will then recognize that without education there can be no growth and without growth of individuals there can be no progress. Rarely has a graduation address failed to dwell on this aspect of education. Yet much of the student's previous conditioning in college creates an opposite attitude. The Engineers' Council for Professional Development has recognized the need of engineers for adult education, particularly in liberal subjects, and has strongly supported the demand for adequate adult education.

A. *What Has Been Done*

In Denmark, "high schools" have been established to provide liberal education for adults. What has been accomplished in this field in this instance is strikingly described by Sir Richard Livingstone * in these words:

> . . . the Danish People's High School, should be of peculiar interest to us for it is the only great successful experiment in educating the masses of a nation. It has reached the very classes for which we have done little or nothing. It has taught them to care for subjects like history and literature which seem remote from the man in the street. It has transformed the country economically, given it a spiritual unity, and produced perhaps the only educated democracy in the world. Here is that rare thing in education—an ideal embodied in fact. It is curious that it has excited comparatively little attention among ourselves who are facing the problem which these Danish schools have solved.
>
> We find it difficult to think of Denmark as a poverty-stricken country lacking in energy or enterprise; but such it was in the early nineteenth century, and its transformation into one of the most progressive and prosperous democracies of Europe was largely the work of the education given in these schools. . . .

B. *A New Area of Engineering Education*

We believe that the colleges and universities of the country should take the lead in providing adequate opportunities for education in liberal subjects for engineering graduates. In many cases this may involve considerable rearrangement of schedules and programs to accommodate evening classes. The teachers of these classes will also benefit greatly because, for the first time, they will have students whose "experi-

* Extracted from "On Education" with the permission of the publishers, the Macmillan Company.

ence of life" is fully as great as their own. The class members will thus contribute much to the instruction of the class. The value to the nation and to the individual adult student far outweighs the difficulties which must be overcome to provide such opportunities.

V. The Most Important Factor in Education

Although revision of engineering curricula is a laudable undertaking, it is almost useless to consider such changes apart from the teaching staff. The failure to stress the significance of outstanding teachers in college education is to neglect the most important factor in education. No opportunity should be overlooked to attract outstanding engineers to the teaching profession.

The question has often been raised as to whether there is a wide difference in salary levels between industry and education which deters a young man from considering a career in education. The problem is well illustrated by a recent comment by Dean C. J. Freund of the University of Detroit: "There are such (ideal professors) but most colleges cannot afford them. It has been my experience that after an outstanding teacher has been developed, he will some day be a luncheon or dinner companion of the president of a manufacturing or industrial corporation. He impresses the president who very soon thereafter offers the professor or assistant professor a salary which is fabulous according to college standards. The professor may be an idealist and he may be devoted to his university, but there are limits even to generosity and heroism."

A. *The Contribution of a Great Teacher*

Many schools would undoubtedly never be able to employ a full complement of outstanding teachers at adequate salaries. Such schools would find it profitable to make use of undergraduate leaders selected for their brillance and teaching ability in order to obtain maximum benefit from the really few born teachers which the college could hire.

"A great teacher is a man whose personality is so attractive and whose character is so fine that by unconscious tuition he wins the admiration and lifelong devotion of his students and all unconsciously influences their ideals and molds their characters so that they are forever after better men for having sat under him. There is no substitute for the inspiration and guidance which such a man can contribute." *

Wherever there are great men, there is so often a great teacher behind them. There is nothing more important than teaching. There are many outstanding teachers in the colleges now; their numbers must be increased. We must have the best and most capable men in the nation guiding the education of youth.

VI. Leadership—A Pressing Need

No discussion of college education would be complete without mention of leadership. America has long been noted for its educational system, in particular for the high level of the average intelligence of its citizens. In our desire to improve the average intelligence, we have more and more neglected the brilliant individuals. We

* From "Unconscious Tuition," by Harvey N. Davis, published in *Mechanical Engineering*, February, 1939.

must recognize that the contributions to society of an Edison, Marconi or Alexanderson are far greater than those of scores of John Does. Without depreciating the necessity for mass education, we must in the future concentrate on developing an equally good system for educating the outstanding individuals.

We have great interest in the proposal that undergraduate leaders be selected to assist the regular professors. These carefully selected young leaders, if given proper freedom, could do a much better job of stimulating the students than some of the present instructors who remain on the college payrolls without promotion for several years. The average pupil would thus simply go through the classes in the present manner, the outstanding student would get the extra opportunity, responsibility and incentive of teaching a younger class. In addition, the substitution of these undergraduate leaders for regular instructors would release sufficient funds to hire a few really brilliant outstanding professors. Such men would be required to have the ability of working closely with the undergraduate leaders, stimulating and inspiring them, yet making each responsible for his class.

VII. The Aims of Education

There are then these principal goals toward which the colleges should continue to strive; a stronger emphasis on broad engineering fundamentals, an appreciation of the role of the engineer in society for all college students, and the creation of leadership of a high order. The degree to which we can attain these objectives will determine the future of engineering and of all America.

Critical Shortage of Graduate Engineers in American Industry

Report by A. A. POTTER

Dean of Engineering, Purdue University, April 14, 1945

Purdue University places its engineering graduates with about 400 companies. Uninterrupted requests have been coming in from these companies for engineers with ever-increasing urgency during recent months. To obtain a picture of the present critical shortage of engineering graduates, a communication was sent to about one-third of these companies to ascertain their present shortages and future needs. Names were chosen with a view to securing a good cross section of American industry. Replies received revealed the following information:

105 companies replied.

8 or 7.6 per cent indicated no need for additional engineering talent

97 or 92.4 per cent companies, including both large and small industries, reported a total need of 4,590 engineers.

47 avegare shortage of engineers per company.

The companies which reported may be listed under the following categories:

Aircraft industries	7
Chemical, rubber and oil industries	25
Construction companies	3
Electrical manufacturers	18
Machinery and automotive manufacturers	22
Railroads and railway supply companies	3
Steel and other raw material industries	6
Utilities	6
Miscellaneous	15

The above survey, which included only a very small percentage of American industries, revealed an urgent need for 4,590 engineers. This would indicate that the total need by American industry of fully trained engineers is certainly many times the shortage reported. This is particularly serious since the output of civilian engineers from all engineering colleges of the United States during the present year will be less than 2,000 and will be made up largely of individuals who are physically incapacitated.

In addition to their present urgent needs, the companies were asked to indicate their long-range needs after the emergency is over. These long-range needs for 96 companies total 3,509, or 36 engineers per company. These totals will not be affected by the return of veterans since the companies took this into consideration when reporting.

The following typical statements from companies are of interest:

Company A—"Further inroads on our staff as a result of the more stringent recent Selective Service requirements would doubtless seriously im-

pair the operating efficiency of our organization, particularly in the Engineering Division."

Company B—"Our greatest need at the present time is in our engineering force, both in our engineering departments and our factory. Lack of adequate engineers has hurt us particularly since our product is of such a highly technical nature. If the sources of engineers, such as your own college, are temporarily obstructed for a few years, we feel that it will hurt us immeasurably, as well as American industry in general."

Company C—"Our war work has increased tremendously the responsibilities of our Engineering Department. However, our technical staff has not been increased at all because of the extreme difficulty of hiring new employees. We can say positively that our war effort has been retarded by the lack of a sufficiently large engineering staff."

Company D—"We have only been able to do our engineering work by retaining employees who have passed their retirement age and by resorting to 20 to 30 per cent overtime, i.e., over and above a normal 40-hour week. The older men are being overtaxed and the excessive overtime results in inefficiency and is, of course, extremely expensive from a standpoint of production. We are doubtful whether such overtime results in any percentage of increased production when it continues over long periods."

Company E—"I am glad, to the best of my ability, to supply you with the information you request, as college trained engineers have contributed substantially to the development of our company, particularly during the trying period of the War, and the present scarcity of men with engineering training, as well as the limited number of such men who will be available in the immediate post-war period, is a matter to which we have given considerable thought."

This survey indicates that the United States of America is now confronted with a critical shortage of engineers. This may prove a serious handicap in expediting the end of the war in all theaters of operation, as production of war equipment is bound to be unfavorably affected by the shortage of engineers who have the knowledge to plan, design, improve and supervise industrial production.

The ending of the war will find this nation with many of its natural resources greatly depleted and facing from other lands the keenest industrial competition ever conceived. To keep full employment in industry in the years of reconstruction adequate engineering and scientific staffs must be made available to develop new materials and better articles of commerce, and to manufacture them in large quantities at low cost to meet world competition.